INTERVIEW WITH DR. GEISSLER

IS IN CHARGE BASICALLY of the autonamic area of development , that means autonamic theory and development, specifiacaly system. And in charge of in general'. That invollves control, problems ~~particularly~~ trajectory shaping, and guidance . The element of guidance consept, guidance and control concept.

developed what is nowastionics. We have which is concerned with the aerospace involvement problems . That means the condition of the natural environment as it is encountered by the vehicle, primarilly wind to some extent and distribution.

Also testing, flight testing, is toa large extent centered in our laboratiory in so far as in flight testing and training of flight traing and flight mechanics are a frame establishment of the real trajectory compared to the predicted trajectory is one of the points of departure. which we find in many parameters which are important to engineering. elevation of thesis of problem. So even though at the last three organizations which were about a year ago, where systems engineering position was established the flight elevation was such had been tabled into but during the whole ~~thing~~ [day] of the second program it was exclusively in our laboratory. And now we are still handling the

So that is about , you may want to have a look at autonamics. We also have developed in our operating laboratory facilities, as you know,

and astrodynamics in charge of flight mechanics. That means performance , optimization, and development of guidance keys.

and analysis division which also handles

and primarily here is more of the principles and the mathematical schemes, and here is the actual planning of flight testing. and the operational phase of it. the responsibilities of seting up operations. Dynamics and control division treats special dynamics problems and control problems. involved as approached to guidance . I don't know whether you know the distinction. Guidance is essentially . You make the flight test good as is our point and control is to handle the ~~application~~ [attitude of the vehicle] to make sure that the moment and are balancedas and then , we won't go into that . This is the kind of necessary condition if you handle a trajectory as a point trajectory you can handle it simply as described here. But if you consider it as a primary body , three dimensional body, this moment you have to go into the .

Finally the aerospace environment divison, is the one that is concerned with environmental conditions.

So we have
and space environment which is for our satillite project. So this was pretty much even though the organizati n was with minor modifications, but what pretty much came through also our contribution. We . The only planning of projects were normally held in a different office or division. I don't know exact name at the time at this second, but its now called the PD. Program Development. The systems office is more a place where which is in charge of the particular project from management. point of view when you put it all together. This is where you might call disipline set up hereand you know other laboratories , astrionics laboratory and what is now called operat on and the engineering laboratory.
Now also we have in our laboratory a systems and project office. There are a number of people who are project types, in other words, there is a man or two men or a number of people and they are the ones that run or
and they will together then with a satalite systems office , so you might say it's a matrix type operationwhere input according to projects or input according to disipline. And of course the other kind of , it's kind of contacts. Now it's key what is not clearly in focus, even though we have something of this for instance, xbackxonthe second office was established after the sometime. We had the consequence something but fairly well defined. as far as I dcould, but we had always in the of this department PD
I think it was called the planned project office or something like that, future project, or and at the time when the Saturn was conceived here it was under Mr. Keller. If I'm correct, at an early time I use this was xxx even another part of another laboratory.

The present staff is the mechanics laboratory, but then it was put on a separate business of quality, I think. You can verify Von Braun used to have a pretty strong interest there. Concepts of new projects so it was kind of at that time. He brought his own people, but at the same time Heller was supposed to be my contact . laboratory. So its hard to say who to contact .

Question: But I would say that there is one idea that originally that corporation between Von Braun and project office.

Question:

What question seems to help the fact that the clustering as we understand it first of all that the clustering is not designed in the flight vehicle.

Answer:

We designed how we wanted to fly it. Do you mean the operation of the. We were talking to the other day.

Question:

We were talking to the other day. If there had really planned for a series of flight missions. it would have been a different design than it really was.

Answer:

Yes. The problem was to some extent that at the time when the saturn waas started, SaturnI, the concept, it was still under our power. It was still under the Army advanced research; I don;t know what is . Project personel. and we were anxious to get into the rockets space vehicle because it was still at this time. This was a military organization. We got the feeling this was necessary but we had not as yet come to a mission for that launch at that time. They had the strong feeling it would be useful for military purposes or other pruposes and ought to be developed. There was a defined mission payload at that time. And later then it was approximately in 1958 the concept was started. under our power. And then in 1960 there was a decision by President Kennedy to land a man on the moon and then the Cl copter concept was all the some extent development vehid e but it was ready to be advanced, the engineering designs were decided to make this into it was recognized pretty soon that this rocket was too small to really accomplish a manned lunar landing and the feeling was probably one should not make too big a step from the previous stage to the larger stage Jupiter mission vehicle which we had at

They felt we might have to go into two or maybe even three steps. So the vehicle, the rocket which ~~was the~~ would be big enough to serve for the lunar landing.

A number of years was pretty long here. Sometime you need a whole fam ily of intermediate Cl to ~~choose, to decide and find~~ C2 , C3, C5 and finally Nova

complex project .

Because the Cl was                     at a time when the manned lunar landings but was not yet postulated and later when it was thaen the question was how big a step can you make at one time. Should you develop the whole family of intermediates rockets ~~Should we develop the whole family of intermediates or not~~.

and develop right through the stages you might say. Two intermediate stages, Cl and what we now call the Saturn IB. By the way these are our models over there.

Yes I see the Saturn V a little low there.

The Saturn V is here.

the whole family of Cl, C2, C5 intermediate steps. Now the

all use common elements. For instance there second stage and the Saturn IB so called four piece stage was a certain stage on the Saturn V. Itis powered by 1 J2 engine and have now

the rocket concept was first felt to be the biggest , the quickest way relatively cheap to get to a more powerful rocket. By combining a number of existing rockets more or less at least the structure. But then it was also recognized that this one would be a very complex operation as a large number of engines and even the structural dynamics of such a vehicle with tanks joined together each very complex. The prediction of the dynamic characteristics , how determine the frequencies of

this is pretty difficult , more difficult than a single package. After we learned alot in going through the flight , ten flights of this Saturn I, and this is not all of them but most of them. And we learned alot about the radical treatment, how to predict the electric characteristics of such a vehicle. And this is important because there is a very strong connection between the control of the vehicle and the structural dynamics. Now we have found that which activate our control systems are bigger engines and if they are based ina locationthe vehicle due to the control effect to support system may be deformed and then the may be a visious heat pack. It may it makes thing more and more and finally So this is pretty important what is capable and advanced classified modules, the frequency modules. How does that effect the frequency, and then one can place the center of the controls in the proper location. so as to make sure that the instability will nott occur.

Question:

Did you find that you were placing centers in different positions in the SI and the SIB? as oppos4d to Satrun V

Answer:

Yes. We had to approach Each of the vehicles individually and the we gave was not to say we could not use the same location but the extense we gave was each set was a basic tecnique. What equations to use, what kind of similation technique, and we had methods developed which we could apply to the next stage, but we could normally not have now. used the results. As a matter of fact the also we had a the stability propertiesof this stage of the problem. And even in Saturn block 1 and block 2 we are going on the unstable properties consideration but there is nothing to see. Block 1 and Block 2 was the one which was a fairly big thing. The reason for introducing these things were that the starter for Saturn L, the starter that went here after we were things to talk aboutignition and that was the first thing amanned mission was the dinosour.

because we said the increase of the failure , the control failure in flight if the vehicl e was naturally stable and moves with the control system, but doesn't work you coast along. was the reason that unstable vehicle on the opposite end of the we would turn over and maybe in a few seconds you could really have a complete structure failure and would not be capable of getting off the with it or something. That is one reason we put those heads Fins on the Saturn I. Now the mission I don't how long we worked on this , but it was a fairly and we went into all kinds of areas of I think I would get about three quarters of them here, but I couldn't tell you exactly when. In '62 I think. Following we made a very complicated study and then there was a long time in which we were kind of suspended. We The Saturn I B let's see how that goes now. The second stage active results . One rational, or one argument which was the Saturn was over was wanted to go into hydrogen as a propellent. That is srp. Because it's a high specific and we thought the vehicle would be good tested , test the structure, the technology with the hydrogen. The second stage of Saturn I was the first step in that direction. which was the expertise whcih was part of this project

We even got about the third stage of Saturn B I first which was called the S5 stage and we contacted Convair .

Question:

Was it

Answer:

I'm not sure. I think yes it was, but they were all talking about using I couldn't tell you for sure. But this material was designed naturally for the first stage . The new engine which was the J2. a powerful engine which was made by North American . which I think was started on being multipurpose. I couldn't tell you. I don't think it was just developed for our purpose. I think it was developed .

Question:

Through our technology?

Answer:

Yes It was on the Jupiter project a prime source and then we found we had to changed the original idea of a fuel system to a third stage which would be powerful enough to make the second stage into a vehide, a technical area. The first stage pretty much the same as is the Saturn I, but still alot of statistics however, and each one was operated under 65 to 180

The tird stage was at that time was the converged to the Saturn V because the which was considered the launch vehicle for the lunar vehicle and decided the expertise was good in the third stage which was the for the Saturn V. So we put this SIVB on the second stage for the Saturn V and we also put on the sensitivity to orbit large enough so we could conduct the launch vehicle entry test for the pay loads. That means for pay loads which would be a percentage of the vehicle coming back from the moon. with some involved on the way down. We could approach these parabolic what we call the probabilities which means speed coming back up to what is was coming back from the moon. whih is the over ten thousand meters, you see. We could not quite reach it. We could reach about nine thousand meters, but this was with the Saturn I B but that was already considered an effective test to get a first reading. in order to get an idea of certain earth orbital operations. of the command module. and service module. All of those more or less for the Saturn I. because we had not yet a good figure on the weight which we needed and we thought that the weight should be much heavier for the reentry capsule. Actually operations for the Saturn I . None of this materialized . All of those flights we no pay loads except a few scientific pay loads. You know one time we had some water . This is Pegasus.

But the IB after and flight tests here the third stage of the Saturn V and it was observed to have problems at first. The first orbited manned flight was

Question:

When you began to plot early configurations and moments and dynamic you also considered using test models, didn't you , small models likeprobaly one one hundredth scale model? or something like that, or much less?

Answer:

You mean for structural dynamics?

Question:

Yes

Answer:

You have to make a distinction there. These models are very small normally, depending on the type size of the original . You have something like one percent of .

Question:

Dis you do all of them here?

Answer:

No not all of them. This is not normally our pilot facilites. is part of area test in our in our lab. because we have a bery good per cent we don't need much money. We can all do it here purposely and check out as ability. This is the ting which seems to be quite frequently. in the laboratory in the NASA laboratory primarily, not exclusively. but primarly but also some in the As a rule I think we have some that go from subsoni c to transsonic and into new supersonic . The size is somewhat limited if we want to use large models we have to use other facilities then. especially if one intends to test not only the over all possibilities this means list flight and moment, but possible to for loading calibrations for distributions of other matter over the structure, then you won't have to use models because you have to make alot of gages on the model to pick up as many as several hundred on one test. And a small model wo uld not be practical. So together with we normally would were pretty much in the lead, had a high priority. This was the Apollo group and we could tell them pretty much what we wanted to have done. It was a some what different relationship that in is now. At that time the research centers were very anxious to accept work which was somehow tied ot the Apollo vehiclebut mostly rpovided for them to keep in exsistance.

Question:

How long were these aerodynamic model test continued, up to '66, '67, '68?

Answer:

These were continued even beyond the flight test sometime. For the reasons theat you see we has special , certain special problems, and then alsways we had in flight even though the test flight , of course basically is more meaningful because you can only generate or fully simulateour parameters in this kind of testing you normally simulate the magnetic similarity of course, and the mach number, that means the ratio of the speed to the speed of sound. This considered in comparative fields one of the most important , high speeds, the most important similars in the whole is the ratio of the friction to the inertial pull of the alerons normally have to be compromized. You culd , in this quality have stay fairly low, below the You can only reach, sometimes one percent of the of the area or something, which is

and it was the opinion for a long time of many people that it didn't matter as long as if you had trouble and flow. The lowering of tempe ature is not enough and is very important to assimulate the number correctly, especially if you want to know what is the transition from flow to turbulent flow, and that transition is a very complex subject. I could talk hours about it. I couldn't even

you get transition, but whether you get it as a specific range of numbrs depends on the body shape, it depends on the , it depends on the turbulency in t he atmosphere, and vibrations and all kinds of things, yu see. That's even today do not fully understand , but the feeling was once you got into turbulent flow the center fwas only a mild one , a weak one. And that is correct for many cases, but not for all of them. and it was recognized partially through our , but partially also on related aircraft , the aircraft work and flight. But there were certain phenomena, certain configurations where even the and turbulent flow may be quite important there. When you use plastics effects of wind and pressure on certain in the airplane

we may get over turning moment . On this we are heading a campaign and that was a campaign to make an argument with the rules for hiring capability. I happen to be a emmber of NASA advisory research committee, so especially basically autonamics since 1957. First it was the space perogative and later it was and I used this committee for a sounding board when I worked together with this team people from the NASA facility and also from industy to          this concept. If we succeeded. I don't recall

We succeeded in organizing t ese concepts in their

which is, we used a principle which was introduced in Germany by          . It'sa fairly cheap and fairly simple system. costs not more that half a million dollars and I now have a facility which can test the highest range of numbers in this country. We could work from there. The ultimate velocity is not          the Saturn V. We could not predict the          conditions and at certain technology was appropriated. The military could lose control . We could have predicted moreaccurately than . The men would have had to

approximately It didn't turn out as it was very good but anyway it came too late. ~~It came too late to get this~~ It took us too long to get the contract approved. before          But now,

it happens to be very useful to our

but the trouble is there are even higher economic pressures

we can depend on this, so we are very glad that we could reintroduce this here.

Question:

Now I'd like to ask you if tere any cose paralels between testing and the results of testing aircraft models, such as, tunnel          as opposed to a rocket structure.

Answer:

You mihgt say in the beginning of the whole affect of aerodynamics is in a way less critical for rocket$^{s}$s than it is for airplanes. There is a difference, I'm not saying unimportant, but we have such a powerful department system and the effects of aerodynamics program     is , I wouldn't say negligible, but it 's kind of second consideration. You could make very rough tests

get pretty good performance there data. Now if the ability, that means an occassional center of pressure which

we have to know this because we have to control our system.

even more difficult because you have another          even less acceptable to theorfetical treatment. We have a

number of expentances on the body but
we have at the end of the body is even less acceptable
only to . Unfortunately we developed techniques , some other techniques
to get over this, but unfortunately
performance of the equilibrium between the body and the tank adn your
total performance is proportionately to the tank. So if you make a aten
per cent error you have at least a ten per cent to or worse. That is not
correct in our case. We want to know it and we have to know it, but not in
Otherwise basic tools of course are theories are pretty much the same in the
rockets and airplances, but different shapes. The working knowledge,
the where you combine theoretical concept
with measurement and watch factors and these kind of tings. In that respect we have
to establish new experience, most different from airplanes. But of course we do base
much of our work on existing aircraft technology and knowledge.

Question:

Well, it seems to me that looking back on it that the Saturn I and the I B are just kind
of horrible examples of aerodynamic design.

Answer:

Yes. Normally the autonamics was a kind of stepchild. We might be anxious about the
bad shape, but it was frequently ignored and only afterwards we
and in some cases it was not so much the
rocket's performance but we did not one for the other and the autodynamic
noise, sspecially our machine will not run if you have computor noises,
and we had plenty of computor noises. in or certain hatches or openings or
. We kept on using a amount of vibration
and our level was autonomically as high as the possible level
when rocket motors cross.
That goes to the limit of some materials, and we have to chose
we get in flight again. natural dynamic
pressure, very high degree of pressure . So this was an area which was considered

a workable one. This is something which you cannot do too well in small xxxxxxs. tunnels
We had to go into the very large tunnels in order to simulate the as
by the body as a large pa rt of the also of the small

Question:

Not only that, but you all on seperate tanks in there and you had air patterns and

Answer:

Yes The tanks were tricky. One time we were very much concerned with hydrogen which may leak on the upper stage. As a matter of fact, they had to weld some hydrogen pipes. In starting the engine and there was a question, how much would accumulate beneath those tanks there, a kind of back water reaches, where , breaks where it accumulatedit was a concern that it might start a thermal explosion or something. So we had for several years we had to be careful starting. It was a mixture which together with some sxperts on hydrogen explosion , the name was

Questi n:

On the ervice team you mean?

Answer:

No, he was; it was the understanding of base flowfor the interaction of the rocket fuel. at the end and the autonamics coming into the safe area.

Question:

The base flow?

Answer:

Yes. Not so much from the rocket fuel as the forces acting on the vehicle, but even more from the front of the heating, we have a level of heating. The base flow area is the area which gets a large amount of autonamic heat. Alot of this is conductive, certainly in the conductive heating is just the heating, the air flow getting into the area by the radiators and certain radiations by the from the jet in that area . And in the early days of the Saturn C1 and the S1B we had even some complicating factors by afterburning, that means the incomplete combustion, the in the nozzle itself, plus the addition of certain gases from turbines. which had not a very complete combustion in this area, actual large combustion external of the engines at the base. There was also the heating and, in the beginning at least, even today it was pretty hot and to treat in the theoretical fashionso to a large extent accuracy on tests, but it is very difficult to make appropriate tests. This small wind tunnel models which I mentioned before are not very satisfactory for similating everything that happens in this concentrated base area. We had some models even in our tunnels where we simulated the air flow from the jet engines by flow, just exhausting into the tunnel and then into the model, compressed air, just to get the feeling for our jet flights, and this kind of thing. But still you get the heating relations. You have to simulate , for instance, or something, which I mentioned before. It's pretty important to get the correct collective heating. In radiation you have to go to the high temperature to see them, to simulate. You would have to have a jet of high temperature. Now, we didn't even know what these temperatures were supposed to be in the jet. So we had for years and years Corporation, North American to make all their static tests and measurements of temperatures distribution in the gas to feed them into our calculators and highly what I mentioned is secondary combustion outside of the nozzles is very difficultt because it is cased again according to new found laws. In order to get this realistic you have to have accurate the length of each molecule and the reaction, chemical reaction that takes place, the actual distance between, between the molecules takes place. And we had first which was very time consuming , expensive, and cumbersome. and not perfect either by simulating this small rockets which we filled into the model and simulated it's external stream and its small rockets and tried to measure that . That was not a complete simulation but it was a step closer. It was not quite as small. We had approximately the right temperatures of those rocket motors, but the worst thing was , what I mentioned last was after combustion , external cumbustion, which we could not scale right because it's still too small for that. Now we had another technique which was a kind of developed this . I mean we started that and it was the first ones technique which was very useful in getting radistion at that alot cheaper and a fraction, about ten percent of what those test which I juust metioned We obtained , it was a kind of principle. We had a very short a largeer combustion chamber filled with hot gases with a high temperature. at the rear, exhaust gases from the rockets which would , just like form a short tube expand through a nozzle. for a vry short time. So the flow would be only as long as it was to empty the combustion chamber. which would have advantage. First of all, it was a smaller set ;up, cheaper, you wouldn't have to build a new rocket motor. whcih is a development by itself. But you just have to build a fill a chamber with hot gases . Secondly, The motors wouldn't have to be able to withstand this heat for a long time , so we could build fairly cheap models. Now it all was to depend on the capabilities of NASA, which in a few minutes I can come up with something here. inertial effects, yes. And this testing technique was has been developed as , not by our people only, in connection with short tubes, this measuring technique, we applied it then here to the radaation technique for the measurei ng and for the test which gave us pretty good data on the heating in the, especially in the upper stages. , the hydrogen stages out of the atmosphere. It was not too good yet, but in the lower stage where we had all this afterburning and the collective heating. It canbe combined with also in front of it. So I would say with all of our different techniques and alot of money went in and time and so forth, we get a pretty good understanding and I think can say without boasting that we are probably the agency in this country which knows most about t is particular aspect . But still ist is stiil pretty important today, in spite of all this knowledge. If you get

Question:

Can I ask you a question on the position of your lab in the Marshall Structure?

Answer:

Yes

Question:

You get these designs first from the design group, and then you would be asked to prove them out before sending them on to P and DE?

Answer:

I would say normally if you talk about specificaly not the design of the base, this is the engines. We would probably be the first to get them, based on mathematicl operations. But is again varies from subjet to subject.

because we know more about this area, the At the beginning of developong the Saturn I, probably the very first firing came from the P and DE frequently without tests. based on our estimates and then they would go back and analise what we suggest; how would it influence on the structure alone so that we could get a very heavy structure and this kind of thing. And then we go through a few cycles. Possibly we decide it looks promising, very good; then we go into the tests which are very time consuming and .

Question:

Did you find that other laboratories namely P and DE were less concerned than you were in your predictions? in prodictions on what was needed for structure and some of these areas?

Answer:

This is generalizing but I would say this aspect

If were talking about other aspects, surprising the very good general shape. The pattern is similar. It goes in for considerations. We suggest what shape might be good from the autonamic point of view, but then

and they look into the structural aspects, how much would the structure weigh, what for different shapes, which depends on the loading; so we have to classify the different shapes of molding. And then we come to a compromise or optimum, hopefully a optimum. Sometimes it's a compromise if one department, one laboratory is more or more strong it may result in something else than the optimum. It may result in some kind of compromise. But I think, by and large, it works pretty well. Now,

which is in charge of a particular area tends to be a little concerned within its own area. and be less concerned with the problems of the other guy. This is natural thing. I don't think it was very strong, but I would say that if it came to such a place then the my people and the P and DE was pretty concerned with us. or has somebody in his hip pocket. But they might say the same thing about us.

Question:

That reminds me of all the cartoons you always hear about the rockets and how the structural changes between r and d and the depends on what you

Answer:

Especially frequently there are arguments about the prospect of control. I mean we are in charge of the control requirements and I think there was even loomed even bigger tahn the space heating because of pretty early in the stage of the game was the fact of how much control was we need. That means the first stage, the second stage was controlled by main entrance. So the question was we have to design for. It was a very important question because with those big engines there is a very strong influence with the complexity of the design and the of the operation. The Saturn V has approximately six degrees swivel angle. And this number was derived after very lengthy and soulsearching discussion. It was after we decided at the time , earlier than we had wind tunnel measurements, wind tunnel measurements always take quite a bit of time and for some reason the development of the engine was normally the long term idea. That is idea which pays through development and so we were too early to say what is the deflection angle to begin with, the defletion angle to the swivel angel. We have the designs, we have the are many facts going in the engine and there are we had to make them flexible enough and all kinds of complications. And the same pattern was being with the shuttle. We have a long argument at the for many months. That has to be Somebody had to decide whether we have sixty days for the lower part or whether we take sixty days for the new engine, the hydrogen high pressure enging. But after some preliminary estimates we can very soon telllaboaratory what conclusion have to have about ten degrees. So this is quite long term because everybody asks, now you prove that it has to be ten degrees and we couldn't quite prove it because the variation was in the front, but we knew enough. We knew could tell there was very wide areas and regardless how you did it you came up with ten degrees or more. So we carried it to finally, but it was not easy. I think when you have to do only the business of tensil structures , when Question you do an analysis you don't know yet, you have to make alot of assumptions. And all those assumptions tend to put each other for consideration, so that makes it kind of difficult. There is not yet a straight rule and you can't get an optimum arrangement in everything in one sense.

Question:

Can yu recall an instance in the Saturn vehicle when you had kind of decision where you made a decision , well give them something like four degrees but after testing found that you should do something else ?

Answer:

Well, as I recall it . I happen to recall it fairly well. because I did it personnally. It's always a slight rule. I had an important meeting with Von Braun about the gimbling the second time and I came to one solution, we came to this solution. So I said we have to

Now in that case, the situation was a little different from what it I just said. In that case Dr. Martzak decided we wanted to play it safe. We can go up to six degrees without really on that. So it was So that was not based on how they come to it. In that case he was not concerned. Believe me on the shuttle it was different.

Question:

But when they said go to six there, you had to a little redesigning on the engine.

Answer:

No what I'm saying is that we said are needed and they said let's desing it right away because at six just to be on the safe side. That is the way it was done. And it worked out pretty well. Some people have said it was unnesessaryily conservative, but it was well done. Some benefits from this large end of it which was at the beginning when we made this decision not realized that was in connection again with as the idea was if you had a man on the vehicle and if you would

loose the engine at any time it would be decided to carry on for quite a while. You would be able to continue to control the vehicle.
in order to give the man a chance to either to get to orbit or at least to make an abort. not to have to immediately to bail out but find a suitable occasion. and flight condition. That was , in fact, I think the engine occuability is to a large extent made possible by larger gimlings which . And normally if those things are not clear cut at the beginning , you have to itereate it and find out what it really, it all We had a complete set of ignition definition when we started to design the vehicle. I'm not even sure that was the mold. How we would go tb the moon was completely decided. There ws. Marshall first made a kind of tentative decision for a what we call an earth orbit arund the moon. The idea was , it appeared to us the pay load would be too large to have a, to carry with it a second part to the moon and back. We figured it might be a bit over a hundred thousand maybe a fifty thousand pounds. And our first Saturn flight concept was even the engine was , the entire engine, I don't recall if was called C5 but it was , I guess it was. And so we said probably it is best to go with two into earth orbit . Now there were two more what we call the mold and both case mold, but in one it was a collection of preloaded stages which would be put together in the flight to the moon; and the other ~~stage~~ mold, tanker mold was a mold where one vehicle would fly up with a large empty tank and the other vehicle would fly up and fuel that tank. Now I'm not sure, but I think there probably could have been even four engines on the Saturn V. I don't remember this too clearly. But anyway

Question:

Did one individual specifically important in putting the fifth engine on the Saturn V vehicle?

Answer:

Well, this proposal came from our the laboratory . Mr. ? who was a ?, I could not say with certainty it was just his proposal, but I know it was he pushed something into action. The idea of a fifth engine actually came up through the back door in a way and not for performance reasons but it was talked about because we felt it would improve the base heating. We were sometime there

concerned with base heating and the first proposal was to place the four engines in a kind of circle pattern around , that would be inside those four engines which woudl bevery strong base heating. the of course would be up to the producing a undesirable arrangement. So somebody said why don't we put a fifth engine in which focuses by impulses what comes out of there. So we a little bitand said, yes it will have a benefit, but it really is not absolutely necessary if we put our four engines as far as possible towards the outside. with alot of space in between. what we call, not a circle arrangement, but but more a kind of pot arrangement
Actually it still would have been a good one from a heating point of view, but it would not have been as at a sufficient rate. But thern, Mr. Hallmark told me, he said, is short. We need more performances along the line which was the fifthe engine on there after the flight. And it was a good idia to have it. I accepted this and then we went to battle for it. And we were successful and I think it was very good because I can see the way it turned out. Now I cannot tell you exactly what phases were was relative to this decision on the noom. The lunar mold, that we would go earth orbit around the moon or that we would go with the what you call the lunar excursion model, module. We did say that 1960, '61 ; At the end of '62 or '61 we participated very heavily in studies under Dr. Shay, you know at that tiem came on board and we brought Dr. Shay. He was a very brilliant systems engineer and he collected a number of things from each center. We did not go to Washington only but the we commuted back and forth. About once or twice a week for a time . with representatives of Houston and Langly and also Los Angeles. to really analize and compare the benefits of molds. They're one of several modes which was proposed by men from NASA you knw.
And we did then alot of studies here in Marshall and finally in I think the decision was made in the summer of '61, . Dr Shay came down and I remember, I went into my file. I wanted to see , I gave a speech then, something about studies. But ;unfortunately things got lost , I couldn't find it. I do know that I recommended then that we , Marshall

adopt a position of theearth orbital mode and accept this lunar orbital mode. even though we said it didn't have to be recognized situation to the astronauts. We because it's something in this docking and those operations in lunar orbit which are necessary , it something happens because he's hurt away from the earth and we would be more exposed.

Question:

Do you remember anything about that meeting? with Von Braun. I think it was on June seventh, '62. He came down.

Answer:

He came down.

Question:

You were all sitting down there and explaining the difficulties. Do remember how support for that built up? Because I remmber at the end of the meeting Von Braun said all right we'll go

Answer:

Finally I was the spokesman for the Marshall Center and I was for years the man to the so called senior member of this crew. And I wasin touch with the flight mechanics and control point of view performance point of view. to make a Marshall study and then reccommend. I reccommended that we accept this before the meeting. I had a speech which I had written out in long hand because it was a political thing.

in which we said now we propose to go along with some , finding out how some of the shortcomings , that we said some of the best change, getting a short term, over a short term even though there may be a slightly higher risk of lose of life, but cost less money and less time. because we felt before you can reach really develop and perfect this there have to be alot of tests. We also reccommeded that there be certain emphasis on unmanned measurements to define the lunar conditions that would be. Now that was not originated with us, but we accepted it. as a sound solution. We had some hesitants about the predicted performance of the lunar descent vehicle , descent in stages. And I think we were then right about it. That's one reason why I'm very sorry I could not have our records anymore, because I recall that we predicted about what happend later. It went up by ascension mode. I think the increase was 70 pounds was 50 percent. That was one reason why having this fifth engine was at first appeared almost a luxury . It was avery good, we had a very good idea that this engine. We commited ourselves to again and again a little bit, and finally to we had a pay load of now I think of almost 110 thousand pounds. which we carried up with us. The early stages which was about 80 thousand pounds. It was substantiolly increase.

Question:

Professor, we've heard alot about the Saturn program being the most technically documented program in history. Maybe that's alot of documentation on this. On your desk I've seen alot of these documents recording the NASA program. What happened to the management decisions along the way? What kind of records of these first needs things were kept? and I have been having trouble

Answer:

Speaking informally, the main thing was we get a man on the moon in the '70s and from the aspects we had there was little suddenly. It was only just some little notes we had and. Some things have been documented. very well but that's mostly the hardware. For instance, I asked my assistant Mr. to go into our files and get a few things out which I thought might be of interest to you. But I guess most of the things which we found you have anyway. In looking in this file shortly I came to the impression it was very slender or very limited description of the program because much of the thinking behind the project philosophy It looks almost like it was

Question:

John and I have a great sense of frustration and it's very difficult to find these records. of when , where, and why some decisions were made.

Answer:

If you speak to this committee which I mentioned before, the NASA Research Advisory

Committee, . That was not really in the line position. But they were in an advisory position, considering to us, sometimes reporting to them just to keep them informed on our thinking and so forth. I reported directly to the administrator or to the actural , I'm not quite sure. It was a kind of advisory gorup and the idea was to look at the basic technology which was needed to support those programs, for instance. But since I was a representative of Marshall, was the main representative of the office of manned space flight in the school of NASA for research oriented people. I frequently gave some very extentive descriptions of thinking and planning in order to get their comments. And I found a few of those. There may be a few around here. I'll be glad to take them along. You may have to freely make copies of them, you may have to sign for them. I don't think they're classified anymore. Some of them were at the tiem.

Okay, fwe'll keep them all together and get them back to you. We'll see what we have and what we've found.

They don't answer all questions, just give some insight into some things in this. As I said I'm sorry that even of this much has got lost. I don't know.

Question:

What is the procedure for clearing out files, every two years?

Answer:

Yes. We're supposed to , not any fixed tiem, but we have to periodically to keep our files in reasonalbe size.

Question:

Well, we found the labs like to hang on to their own material. That's why they're not over in the central files. If you go over to central files, they say well the lab directors must have it, and after we were over to the central files, we come over to see you and you say you have , you know, in general it's

Answer:

I don't know whether it's I would say I would not mind at all if you wanted to spend your time to look through my files. I thing my problem is we were there so many months physically, and there are changes in , I couldn't help myself, even the filing system is not familiar anymore. There were changes in and those people who did it. Now there's a man and he may not have understood and it may very well be in the files, but I'm not sure whether I'm imposing on you or not because you may find other . I mean you could give it a good try. I wouldn't mind. As I said I made a search. I asked somebody to look into it. I found two things which I I'm not sure if this is all. There may be other stuff. The problem was that NASA found notes and I asked the reqrites. We have to turn over stuff to the service center, but I always considered it first of all a almost irreversible thing . There was so much material and secondly my own file, I have to admit I was never too interested in collecting any of them. I was always interested in the future and not the past. Progress is so fast in this business that it looks when you think about it.

That's not my attitude toward history. I think history is a very fascinating subject, but in my own work I could not feel it as important for that reason.

Question:

Yes, I think that's the mind text, the of the working. If you could comment from your point of view about the relationships between NASA and headquarters and some of the others . Did you feel, for example, that there was a greater affinity between NASA headquarters, for example and Houston because of the stronger NASA ties over a period of years as opposed to Marshall which came up through the Army in a different way?

Answer:

Well, to be quite frank, I think the Houston people have the inside track to a large extent. in the NASA family, you know. When we joined , it was somewhat later. It was about one year after the first trajectory had been made. when we held our They were not too enthusiastic the first time heregetting to NASA. and in the meantime though, we many old NASA and people had yet a kind of inside track . They had established certain important positions as a whole. Now I would not say that generally in all cases , I think we got our fair deal in most situations. So we had discipline of being a little outside the NASA personell raises . Most of the budgets of NASA and manned space flight office were big enough that they tried to turn to wherever the talent was and we got our contract. Possible we made our contributions

as far as the first civilian . First we had genral for some time, which then Major came and last there was a very capable man and one which tried to use our talents. as much as possible adn who was his successor? Was it George Miller? I guess. George Miller was a man who also I think, a very talented man, and he was as it was because he trid to get every little detail. We He was a very good man, quick on the ball and going to answers to everything. We got, certainly he I t hink he used pressures terribly.NASA's talents. Of course there was a big basic problem , that is the complexity of the organization. I mean there were just too many people and different organizations, different centers and the headquarters and all those complexes. The challenge for management, how to manage it, I mean for us the conditions under the old ways prior to this joining the NASA family was AD and A. We were running it actually. There were

which gave us the environment and managed us. With ur technical positons we could make pretty much a very small achievement on our own. Now after we joined NASA this changed very drastically. We were come all at once with decreased, it got more and more complex. And we found out we couldn't make a decision without holding conference with so and so and watching it with so and so, so they had to stop it for quite a tiem for management concept. But we, of course this was finally up in Washington that , we had something there because not everyone all decisions came out of Washington. They were completely practical. For instance, we thought very hard and succeeded reasonably well to establish a management group , or part of a management team of consistingofworking groups and working plans in which all interfaced on the Marshall and which then played a very important part. It was established in disciplinary areas . There was flight mechanixs and there was flight testing and there was structural mechanics . A panel which was composed of a number of knowledgeable specialists in each center, who would sit together as far as a regular interval and discuss all the problems and come to strong reccommentations. or if they could not come to a joint recommendation it would go then to a center whch wasj chaired by General Phillips., who, by the way is a very capable man. His personality is

because he was very knowledgeable and also a man who would always listien to other people, not just what was his opinion but come to a field decision. And this office, General Phillips being the kind of officer there we would know if we don't come to any decisions we have to go him. We couldn't go to and many problems after the initial fight and jealousy between the centers we got to a pretty good working condition. This worked very well. In the same with our contracts. There is even the question relations between the laboratories now. We have for years flight mechanics, structural mechanics, structured not even to one contract. even have a different set up. He's not organized like we are. So we again established a contact of working groups. where we would have a numbr of key people form from several laboratories get together with the , I me n key people from the contractors. and such other problems. and keep them then in the

Now that's part of the management. I know you realize that. but it was from our conceptualization point of view very important one. And that took a few years.

From our point of view sometimes he was even a little bit too serious. But we may have been but, I mean we know he was the man who and very seldom came to but sometimes we felt we should have been listoned to . our situation was in the system, but he saw the picture I guess better thant we did so , I think it was pretty successful.

Question: I assume you went to the LOR division , which means you would be making less , less launches per year.

Answer:

Right, Of course, that situation should not be so called because we had to realize that since we had not succeeded in the whole budget thing at all I think

It was , as I said, we had the , rather sceptical towards the claims of how much we weight would be needed to bring this luna descent and ascent stages. But even with this margin , I mean this increase , it still I think a good decision to make. Of course, I would say one thing which was surprising , I guess to all of us, was the fact that the how well everything worked. I mean even the optomistic people would not have dared to predict such a high rate of successes in our projects. We had before looked at the previous project. We all had in the ot her ones thirty, forty, some fifty per cent successes, but not more. in flights. We had some failure. We had no failure what so ever, no complete failure. We had problems, yes, but no single failure.

Question:

How do you explain that?

Answer:

Well, it was in a way recognition that we could not go to some sloppy appraoach whcih was used with the military, but which was the time and the so forth and was located one thing. It was against time and less money.

the feeling that everybody's looking at the space program; and psycologocolly and also financially it was . We could not afford a failure. We had to fly this one through outer space or the astronaut would be sitting in a very dangerous , he would be killed and we would have a lose, the reation psycologgically then would be And secondly lthen sheer size in terms of money. This means so much that we the pay off is difficult. Part of this time was spent on the more time on the improvement than maybe we should. So there was a tremendous effort to , checking, and testing and so on. I personally would not have thought it wuld be such a success.

Question:

So this is. We have. John and I both have been a little bit vague about manner rating and what it means. And this is just, this is a good example of it in that case.

Answer:

Yes. I guess the best you get is very good thing from Mr. . if he tells you about this. Certainly he is not only that, I mean, he is in charge of

Question:

Who's this

Answer:

Of course there is the philosophy has to be from the very beginning and our ability is designed into that. It takes both. Ttakes the quality control and the final execution but it takes also some of the conservative design, you know. How do you lay out a conversion flow, or the possibilitys you could tell me but that's one thing we didn't talk about. That was also I think a major contribution from our laboratory , the good definition of the wind field. It was not too well understood and we made a number of contri utions there. First of all, tools, how to measure things more accurately, and then the significance of the phenomena. where very high occur. which were airplanes probably at that time recognized. This was a strong closing point. for our control design. We , at first when we started to establish our control basic parameters, we had to predict understanding of what what was happening in the atmosphere, what it would be called, and we had to work on more. We were lucky. We turned out pretty good.

After we look back it was not more launching over the sun and was just having a reasonalbje almount of , I guess a certain amount of luck is important.

Question:

That reminds me. We were in Los Angeles talking to some designers of the JT engine Somewhere in the conversation it came up that even sometimes in engines it gets to be a kind of a black art. Something happens and you make several changes , but you're never quite sure which one .

Answer:

Engineering is a mixgure of xxxx science and art. If you want to be just strictly scientific you just can put yourself out of the business .

Question:

Do you begin to develop a feel sometimes that even though you couldn't really prove it out that exactly

Answer:

Yes that is right. That is part of the reason for the success of the Von Braun team. The Von Braun organization, yes. I started in 1940 when I first came in form the university to work on the V2 there.

Question:

What stands out in your memory as the as far as the Saturn program as real highlights ?

Answer:

You mean conseptually or as events or

Question:

Well Maybe just events.

Answer:

That was in the first thing or not as far as sheer physical project.

Question:

Saturn V or even the first Saturn

Answer:

Yes . I mean technicalogically they are still many aspects we have not even touched yet. this propellants for instance. which was a challenge Even though we had a difficult thing on the Jupiter.

Or at least it was we didn't use it; it did not work properly. And we had to develop an appropriate theory predicting the motion of the vehicle. the rockets So this was a very interesting theory. It was Dr. Baur who worked for me. He is now with Georgia Tech, a professor. He did alot of work on this kind of ting. What I started to say, it was such a long time now.

Question:

Around ten years. So many events that . Your secretary didn't warn me that had another appointment at 2:30.