RCA

Memo From

D. E. Wise

TO	LOCATION	DATE
Bill		

Tape No. 16

01-089.

Don

01-01-018

WUENSCHER
WIENSCHER

"Interveiw we with ~~Wien~~ Wienscher, (questionis garbled)

". . .now either our contract engineers you know, forced the contractors to do the same thing. So Y ou might see any thing in our statures repeated, or maybe it was intelligent that the contractorspreferred to do it the same way as well. This the assembly pictures for Saturn I , it is all g here , because we did development the Saturn I entirely in-house . And after we had the ten Saturn I's we turned it over ~~counted all~~ to Chrysler, so they came in a litle bit too late to do any devlopment.."

"Did this tooling and the pictures and stuff go down to Miss U. then?"

"Yeah. We delivered to Miss. U. and they might have been another set for that. ? ? But I mean they did it exactly as a production contract, getting the complete set of drawings the specifications and everything because if you built already ten vehicles and then built another ten it was as a complete sub-contracting ~~or~~ of a developed uni______ They made some modifications, for their requirements on weight saving, which we had started to develop here ."

"Was the weight saving program going on all through the development cycle ~~site~~ as you found new ways of doing things, would you modify each vehicle as you went along?"

"Yeah,actually the OND of the research and devlepment was always justified and only possible on that basis to be funded ~~fronted~~ . To say we have our present vehicle in development it es already maybe in the product development , so that the points are already made sothat the motors or the configuration is frozen. But it could be that we have to save weight,for, instance especially in the Saturn V that may be the lunar pay-

+ 2

load exceeds the limits and then somebody else has to make up for it andthat could be to make the first stage lighter, make the second stage lighter and so on. So especially for the first stage , which we built here , the first four of the stages before goin tothe oval, they are, I personally run a large structural development program and all of this represents 30% structural weight. We never incorporated that program, we incorporated only a 20% tank weight saving , by introducing one of the modes which I developed . But the others was then to go from aluminum basic interior to advanced technology's using titanium and using oil diffusion on the methods and changing the tank configurations. So . . ."

"Are you talking about the SIC now?"

"Yeah this the cSIC. You might have seen this , you know we , that was in when. . '65. . . this a NASA Memorandum . WE had one afternoon for manufacturing rese arch and our work is hard that time , gave a short opening t ad and our people collected for it , the different activities we are doing and this was all in respect to technology development, working problems, this was our electric Himmel development,which I introduced in springtime Swimhimmel . .yeah we have manufacturing researching support of SaturnV the h-forming was one of the major introductions. i In a nutshell, the Redstone and Jupiter Vehicle was a common-dome configuration . "

"You mean a dome with all kids on both ends four and one half?"

"Yeah. you have normally only two tanks ___ ___ and the oxidizer and the one basic question in rocket building, that was, wheter you make two tanks with the end fo of six feet in-between so this here then the locks tank and this the fuse tankand you have the end of ~~stare~~ stage in between , although you make one common container with a common dome and this is here th then, let's say your field ."

"Common bulk point."

"The end has points and still has the common bulk head. So had the Jupiter and the Redstone vehicle."

"Would you do that now, still use a common bulk head?"

"In the Saturn class we went to seperate tanks. SaturnI becarse it had b the blast-off tanks andit had one central lux ___and it had seven tanks around there with for more lux ______ and four mao more tanks, so you had seperate tanks. And then in the booster stage for the Saturn V we wentto seperate tanks.

"What about the F2 and theF4B . . . "

"The F4B has ~~dome and gone~~ a common dome and the F2 has a common dome."

"Would you still build them with common bulk head if you were doing it all over again, or would you go to common tanks?"

"The bigger a vehicle a gets the more impractical it is gets to build the configuration in one piece . This is so, one factor is especially decided. Because if you have one large stovepipe to install the breakheads and that is 33 feet in diameter and 80 feet long, then it is much harder to handle, you need much higher facilities. There for instance , when you have to turn the stage upright there no plane crane _____is sufficient. And you can also only employ a small number of people, but if you break such a unit down into the two tanks, you can have two assembly linesp parallel, you can live with your buildings. So I mean . . . "

"So that was one of the ~~impr ovements that~~ reasons for the FIC haveng the seperate tanks?"

"That was the main reason, because everybody came and said

why don't you do it in a common dome , because that's frome the engineering, but if you would put . . . so more or less the beginners they finally repeated what we had done in the Redstone and Jupiter and tried to teach us , introduce the common o dome, while we moved away frome that, because if wee would have done the first stage in one piece we would have needed all new ????
paintings . And in fact this happened exactly with the S4B and and the S2 stage like in Seal Beach and in Huntington Beach we had hundreds of millions of dollars building projects with new high pay areas with no cranes and it was more crane clearances you know the so-called ______Tower in Miss?? U
Boeing proposed to devise such a _____Tower just to (unclear) While we build up the vehiclesand had to sign it that way for cilibrial sections and there was one with the done and one in between and one with the other t dome and these sections never exceeded the height of 04 40 feet o so we could use and actually force this into the c scheme untill we had this we forced that the Shoe plan , which was the biggest national investment, I thind it was ar at that time the biggest factory under cover in the whole world ., paid for by the navy and the Air Force Herald etc. And then we inhereted that and it would ahave been unusable you know if we would a have had the ot other beside s because it has 40 feet tanks ___ and this is what we had here. So we refused the need for hutting the buildings to the minimun, at least to chest l.

"And you had to argue with Boeing about this."

Oh yeah, they fought that for a long time you know to soften up the management, the people who don't have any technical ideas and help them impose that it was payload and was not connected with the engineering reading program. You know it was really nonsence to put the Cp for the 2 stagewhich was another 56 million dollar investment, as much as I remember. As we put it on for the same reasons it doen't make sense, any sese to fault a $50 million dollar building program just because the designer built it that way. We didn't do it that way it is much harder to work with one bulk item than instead of /???????????????? phone thong things . It is, Valking decided against that because California needed construction work. I mean the money spending is only avialable because you have to keep the people busy, you have to ...

"That's one of the reasons why S21 wound up with the common bulk head."

Yeah. That means that we couldn't afford the building program going with it, it was rather even desired. Rather than build it in lenthwise, build it in simentric sections. Now the simemtrical secrions came, you know have one draw back, that means whenever you have such a divsional section and you weild it and you have longitudanul stiffening breaks the have some stiffening power in there. You have to leave a large peice of weild lend where you jioned with your weilding because if you change your thin skins here, there was no method known how to change the ribs, the ribs had to fit in picture, that didn't exsist. So our design people said we will work in here again and redesign this thing with the wide lend, I developed here a tehnology program how to join the continuos ___________ ~~and we made~~ and that saved 20% tank weight.

That actually made the ~~horizontal attempt~~ ________ ~~assent motive~~ even with the logitudanal assembly mode. I don't know how technical you want to be in your book or what the purpose of it is because this is internal ~~presuu~~ pressurizem.

"No, listen we want to make it as technical as we can."

You know the hoop strass in the frontal method, the longitudanal hoop strass is twice as high vs the consectren hoop strass. So if you make the ventalator weilds this was the area is half as strussed, vs the longitudnal weilding area. So that is what you know for the moment we selected and that is another engineering problem becasue the alimiun weilding for the vications. Now there we two things. If you went to the thinck gauge joins, you know in all of your compensate in that weight area for the missing reptile then it wouldn't bother you there. We had to weild through about 1 to 2 inch of aluinuim which at this time was not yet flecable. Basically the older types of vehicile , the Redstone and the Cubical was weilded on 50 thousand series alumium, 5 thousand series alumium 54 56 that ~~th~~ is magnesiem containg aliumiumm which were ______. That's the so called Cwalller consistent type of alumiun. That is not effected by heat input with resect to strings, but it only is hardened by cold streching, this is called workhardely. ????? So that material was not used in the aircraft because it is hard to form as some as you shape it, it gets harder and harder and so ~~it~~ in order to make the intricate aircraft wing noses and wing tips, with depoing the 5 thousand series alumiun even if it is seawater consistent, that was the most unfavorable alumiun Allen could use and it didn't react to a healing. It had a high nose stength an level anyway. As an aircraft noarmally is weilded as well as it because alumiun wasn't consider to be weilable anyway. Now when the m missile construction came up in aliumum yee you have to build pressure wessles and they have to be weilded. So that was the new technology test to solve the weilding problems in high strings or loght weight structure because the pressure wessle isn't the major the major sturcture or portion of the whoel missile. The misslie, more or less, the Air frame is a pressure ratio.

"Did the Atlas wu use alumiun or is that stainless steel."

Stainless steel.

"What about the Thor?"

They used 20 14 alumium.

"O.K., so that was , was the Thor the first big missle that began to use this stuff?"

No, the Redstone was the first mi big missile, the Thor was the second. Then the Air Force came in and ______ repeating exactally the Tupador. It was the same engine, it was the same size, and the same preformance, an exact duplication.

"What about the Waffle construction of the Thor? Was that ever used ee on the Jupiter or on any other mislle after that flight?"

No. As it wasn't used in the SiC either. Of couse the waflle pattern is not really the potimum for this type structure.

"Well I was thinking in terms of the 3rd stage."

We had not longitudanl , yeah. There was a patern we used in the S4B stage that was we used, also the S4B stage used a compliment of, it used the same _____ abd bulkhead method. We proceeded actally from the cover dome method where the dome was slipped into the brid. It was lead weilded here. You know intally you have your autobald and you have a certain step in strentgh anf and consistentecy from that accectplicity and whenever you weild such a coil you know where the whitehead shines here and you X ray it, you always see that making lines in your telescope where your bulkhead or your section is telescoped onto h the other one. You don't know whether thiscrank is a wield crank , somewhere in the weild or whether this is a crack were your structure starts to split. It is also a naturalway of crack probogating cause. So that is the weakness of any such lap weild, whenever you weild some-h-i thing together t at way that you still have _______, which in fatigue life later will probably get a crack into the weild on one hand, on the other ha d in you quaility or rather humidity control program you can not reall clearly design, rather this is already a crack or it is just your telescoping. So we thought this problem with the 5 thousand series aliumum, I mean we used the 5 thousand series alumium because they were not insensitive and for that reason you could weild it and you didn't lose much strength. But they didn't reach the strength weight ration of the thermal treatment aluinum, like the 20 thousand series of copper content. But when the technology progressed you knw the automatically controlled ______ methods through the development of completely automated inert gsa and metals ~~methods~~, controlled withall types of electric sensor systems, and really the weighting machine is absolutely a very highly automated thing. We have spent many hundreds of millions here, in our lab, for development of

9

of weighting technology. You have my deep dimensional contributions in that area for the general technology. Now after ____ meeting we worked harrd on this 5 thousand series aluminum for really the structural weight application, I mean not just for a beer can, we progressed into the 20 thousand, which was used

?feen 4

by four also , but 24 feet is a ~~20%~~ cover. So whenever you weld

? team

this the 24 feet it was king in strength of weight ratio " 24 team fully heat treated it was about 20% better than the 5,5456 or so . But the way the building was modulated caused us that 4% cover. And so you have so called microfficials and cover completed areasbe because as soon as you nicklfy that

concentrates

the cover just ~~turns~~ to a utectic and you have in areas the cop-

a

per content is lost and then you have ~~to~~ soft aluminum ~~ccccccc~~ property. So the big problem in 20-I4 welding still exists and it has existed throughout the Saturn program. Twenty fourteen was then used for the S4B stage and it was used for the S2 stage . But the S4B stage was contracted out first to Douglas and they had reccomended 20-I4 and they had done the mat welding method 1

bulkheads

like this shifted in ~~b~~ there under ____ as we had done it with the 5000 series with Redstone and Jupiter. a And they

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used also this type of technology they did not go to Butwelds. You know of course the better joiningmethod is if you really can control your weldment to butweld, so that you get a continous configuration."

"And you can check the crack structure much better too."

"And you can absolutely control it so the more aligned the weld, the more sound principle is butweld. But in aluminum we didn't think of as the early tubicle vehicle to do that, as for B stage we didn't do it and we didn't think of even in the Saturn program to do it with a cover containeng material.

Because that was horribly weld . Sothe strenght th to weight ratio advantage of going to the 20,000 series cover containin alloys was like in the S4B completely wiped out by still resorting to t the old level technology and applying a much higher safety ratio. Sothe Douglas welds are only loaded to 20% of their capable weight strength for uncertainty reasons and safety reasons inherent in that _____ weighting problem. Now we used here at Marshall neverthe less a cover containig alloyb but that was the 22-I9 which is a six person cover alloy, and which wasn't considered to be weightable at that time. Which is in fact the old I909 door aluminum alloy where the first airships were built from. This was the two highest strength aluminum alloy for six% cover which is a new tactic point within the cover aluminum. And Alcoa in their Canadian plant had taken up this dual-aluminum production , I don't know some years ago, and they had verified the alloy a little bit , you know with more ingre dients and really this whole thing is like cooking, in fact we hire metalogist who is 25 years with Alcoa, who is a spinster had printing , and she's now over there materials, so she's a good cook and she's a good aluminum maker because you have about 6,7,8, ingredients and you put a little bit salt in it and you know what happens you try it out. So Alcoa actually improved the ultimate dual by some small fractional per cent of some ingredients especially titanium. To make the welding feasible, and in fact Boeing pioneered this use of a 6% cover alloy,22-I9 ,with their Boe Mark Missle. They had a thirty inch diameter tank in the BoeMark, 30 inch, just allittle bit more than two feet and thatwas 22-I9, and that was welded up in butweld. And we went there o to see _____ that must have been in I960 or '59, and studied that. And finally after ~~many~~ maybe one a or one and a half years of better launch ___ and weight development selected this for the SIC stage. To date 22-19 is the only considered ~~to~~ aluminumm alloy for any fututre space vehicles. Twenty fourteen is reaslly on the way out because with that crititical behavior with 4% and unutactic and so on . Now the interesting factor, the s strength to weightratio I mean the ~~whole flight and~~ 5-4 strenghh to weight the whole flight and aircraft , a materialwise higgher strenghto weight ratio at the joining I mean like welding , now this 20-14 which was developed not for welding but for strength in ?king? strength to weight and which is used in aircraft, which is a heat treated alloy. Whenever ~~hea~~ _____ it, it gets soft like cardboard , so you can form it, and then you age it again and it gets really strength to weight ratio of 20% better than any other alloy. You know thatfor being relative to for being relative to __ __and not welded, that is still up to date topnotch aircraft. It was, so ~~hx~~ the old deul alumiumn which was the ~~airsph~~ airship and let's say the first world war general Gentle lin alumiumms being 20% lower than 20-14 , that got more out of fession. That got out of fession. But the Alcola developement, heat developement out of that alloy, yeilded a combined heat treatment, a combined treatment. That was the over mat of, heat treatment was a cold work at which you had to stretch, you would weild the 5 thousand series and also the find the 5 thousand series because all of these are stronger and harder cold working it and maybe strechting it. It didn't react to any heat treatment at first chilling, the cover containing alloys they reacted to the heat treatment in order to harden or soften them. Now the combination of that, and that was really the major discovery that to strecht the 29-19, the 60% copper alloy, to stretch it 10% and then you heat treat it , that increased the strenth by about 20% and that part is 22-19 alloy. Exactlly in the competitive rang e to 2##. So that was the, really the big technologicalk breakthrough to the have a double drink, which also would naturally would make it a little harder to work with than the t areas. But it is doublw worth it.

"There was a controversy, as I recall, or at least some dicussion about the difference betweem pig weilding and mig weilding in Dallas. Could you comment about that a ## little bit?"They wanted to keep on using the mig weild as I recall and you couldn't see why they just wouldn't go ahead and some tape weilding especially on the S4B?"

The reason or the underlying reason is that the douglas design and mode of operation is conservative. They maintained there S4B weilding and the whole S4B structure remote basically to sell our technology and they did all the weilding downhand. That means whenever we weildied something we put it on in to horizontal postion, they didn't weildi in place and so weild puzzle by cavity just was well in its way and you could make very big weilds for instance in one pass in order to fill the big gaps or so bigger materails. WE got a higher degree of yeilding but also there is strucure in the approach was just to use the weild with 20% of there carrying capiblility. So they were really conservative in their engineering requirements, they were really s conservative in there dueling approach by weilding everything downhand and they didn't proceed to bud weilds so that they

13

could live for relatively plenitive over this conventionary loads.. They also used for instance circluary bulkheads which are not weight optimum therfore the presure ratio the end closure is not as heavy as fiel. That would be the lightest bulkhead that you can build, because the shpereical thime this already have the ball thichness of the clinder one. It's just a basic log . Now, but whenever you connect this to some other force of the vehicle you have to put up a scale here and this scale of planes is naturally also a little longer than the radius of the shpere. So that you can continue with the empliments in design. So the total weight speration for that and is the bulkhead weight plus the skill rate. And ther you find out whenever you make a litrical bulkhead, which is only 70% high, which is allops one over .2 ratio the long vs the small radius, then this area gets a little bit bigger and long but your scale gets 30% shorter and becasue the pressure ratio gauge is all determined by the inside pressure, are more or less not like if anything in long while the longitadan force transmission you know really puts the weight into the scales. The major weight loss actaully in the unpresurized scale structures and in the ____ scale structures. You ~~openise~~ optomize your structure by ~~jioning~~ going to a lithical bulkhead and that was one of my structure and developement things together with industry research to figure out what was the optomum end, tank end plus scale. So in all the vehicles in the S2 stage and in the Nova S1 we introduced it in our S1c stage we proceeded to a lithical bulkhead which was 1/.2 for 70% raduis proportion. Which means a little bit more cooling to make the bulkhead, but after the bulkhead also big you even mighten have know that this is not a hemeshpere. But it is a very essential weight saving , it is a much more essential approach. Everybody does it now , the 2 stage does it as well. But Douglas stuck tothe , even knowing that this stuck in their proportunal hemeshpere bulkheads and also ~~they~~ their covering dome in there has the same raduis so that they would use 12 for making thatbulkhead. That, you know so from that stage simplicity and cut defect or from conventinal playing x it safe reasons, high safety factors and it was using hemeshpereical bulheads and now they someway got a contract becasue I mean they developed to much cheaper, they played it safe and someway made it. But this are the weaknesses of that stage. the stage is not optimum, it has optimum materials but it is not used enough that the configurations enough in the weight chose.

"Is part of that though becasue the S4 and the S4B stage were kind of the first of thd major ~~St e~~ Saturn structures?"

Yea.

"So that Douglas esentially at the beginning of the technoloical ~~a-lat-~~ ladder the S2 and the S1 series ..."

They continued the Redstone Jupiter technology, which they had picked up in the 4 structure and they continued it and because of that optimized this. They, weight and laucnh technoloical contributions is the inside insulation of the tank because the Hydo G was a ~~novl~~ novelity. They had also in there common dome another ~~structure~~ troubles becasue of that relatively unsound structural approach. That was in effect this tank in here sits in the other tank front and this joined, you know that was the problem area which cost many many millions to rectify. And this stimilary means structure has no vehicle which doesn't have the certain defencienies in them. I mean meanwhile we used, it preforms but any time that could be a major catastrophy for us. I don't want to medily to you, I mean nothing is perfect but this was one area where alot of improvement had to be made reduced even to be accepeted. We have spent many, many millions here on all of that with Douglas in order to improve the technology.

"Is the North American common bulkhead with the J ring comming down and the hydrogen tank sitting in there, is that a different configuration?"

Absolutely! Becasue, when the 2 stage was going up for open bid, ~~th~~ North American was doing the following: They said 22-9 and 20-14 is superior ~~to~~ in strength to weight ratio to any other material at that time. Second, the Douglas uses it and successfully weilds it. The thrid things that American said was OK if Douglas can weild that material than we in any case can do as well or even better and the pointrest in their configuration from lap joins to bud joins with that material, which turned out later to be a major cost consuming item. Then they had to, we was then togetherfied and had to solve the unsolveable problem of amking the higher the landing rate join. Also the struss people said, if Douglas has a 80% safety option in their weild in order to dominant all type of small defeciences in that tickle~~less~~ material, then we can get up to 50% safety factos.

So that weilding results was at the same time probosaic requirements. So they had to do better, they had to, that really was the big opstet and the delay in the 2 stage production becasuse of the optomistic, that's the design idea if Douglas can do it, we can do better and really know what we were talking about. At that time the aircraft companys never weilded alumiunm anyway. We had a, they had a small prone which was once weilded in 20-14 therfore, I think 20 ... I mean what happened was the extra prolasion of the structural experiences that the alumiumn riding from the ~~fullmark~~ tank to the S1C33 full tank and in North American from their 15 inch weapons system to the series with the stage. That is what he calls a lot of pitfalls which in technology judgement have ~~alot of~~ to later be developed. But otherwise we had 2 stage use completely the structural principle of the S1C stage abd the electrical bulkheads we type of stiffness which longitudanal T stiffness instead of the old waffle patern and I figure theat out here also a person , this sounds a little bit funny, but this is not him. You know I'm an aircraft designer and test pilot . I'm trained in optimization structures and when I converted half of the 66 ____ really, I feel that this , that we don't really have to much work but there is the missle thing going up ~~and~~ in New Mexico, if you go there you cna see there from here and just throught the foot pond system, they have nothing to do anyway. Which was the Air Force mode of operation, they have thier own mission developements and the SPL did everything, made decisions for the guidance , we didn't even get to the parts. So it was a-all done by the Air Forcw sub contractors, that was their mode of operation. So they had one that left there and came here. But, we the missle design was way off, ~~not final air but~~ were not friendly with the aircraft and lightweight structures and in fact by Dr. Von Bruen and other leading people the structural defiency wasn't considered to be very important. In tone that it isn't our, the developements in the first place, the developemnts of the engines that we worked in producing the thrust, and they guidance and control systems that this thing didn't fall back on your head. With long beam in between, that was a plumbers job and nit nobody cared about that and that was the first order of technology criteria. When I came here, the Redstone and the Jupiter and the Saturn I came about and the vehicle payload preformance was improved. It was always done by making the tanks longer.

"Just add more fuel."

YEah. Add more fuel and you get more of an impluse. You know it was really the lower efficent way and was not really the most clever way to gain more payload by refining your baiscally crude mission structures. That only comes about now with the space shuttle where this thing has to fly as well. But that as long as your expendable you know that the structure or refinement requirement is not the first of the requirements. This is actually the basic difference betwenn aircraft and rocket technology, especially the technology of a expendable rockets. All our wiehgt inprovement justifications , you know when I came here and I saw , they are building thier plumbing team camps as wellas with no regard to basic refined lightweight sturture technology which was already very well known for the aircraft, you know first you'd thing they are stupid and then you find out that they are not so stupid after all that is just the law, the difference between aircraft and missle.

"IT's a trade-off ~~sti~~ situation ."

Yeah the trade-off and it is not to clever to golgplate something which you don't have to goldplate. The emphasis on engines you know and on guidance and control systems finally lead to the perfection so, sense about 5 years you can fly a guidance and control system maybe through interesting catuloges. I mean Sears doesn't deal yet with that guidance and control systems, but they will as soon as the demand increases. So I mean with this techhology wise this was solved around, atleast it was after the 70's. It was after 1965. To the perfection of reliability of lifetime to be operatable for a couple a of years even for Mars mission and so on. Which was found to be impossible twenty years i earlier. And the engine technolgy which also was in the b beginning just a three minutes affair and you were happy if it wint three minutes at h that because it was dumped anyway. You know that was extended especially through the S3B engine and the rocket time warehouse which is the central one, you know, we call it the rocket time warehouse, because it's a warehouse for i engines. (missing) . . . rocket and aercraft technology and because I came from one side and essential penetrated to another and had not participated in the actual rocket development I can see pretty clearly or what we really are doing is working out the possibilities, after the engine andguidance technology is more or less over the hump. The next step to optimize the structural technology. . .

"The structural technologies are still catching up in a sense."

"And this is now the major problem, because of the spacial recovery, this means you have to learn how to build a pressure level let me say that the major portion of a missle structure or a rocket structure is the tank. The major portion of the aircraft structure are the wings . So if you want to build a cross pleat ??????? you have to get the wing requirement or hte aerodynamic requirement together with the ?????sp????? buzshawitel requirement. And that is exactly the developmental work which I started then in the '60's and that was the development of intersecting multi-cell tanks or buzshawitels. Because there is one beautiful natural ____ and this is now the base of line called shuttle technology. That means that several few facts a certain liquid into one pressure level or a number of small ones the rate of the shell is constant, that's a natural law . .

"Does it work for the Saturn I as well?"

"Yeah, it doesn't matter whether you cluster or whether you put in one tank, the weight saving is only inside . But the real clue is because the wall thickness depends on the ~~ratio~~ radius , the radius is directly proportionate to the wall fr figures that means if tyou make the radius smaller than the wall figures are smaller and then the shell weight is constant. That is even true whenever you intersect the pressure if you intersect pressure ____ the intersect you mainly get hanging on you know and you getthis mighty cellular structures which are used By ____ & ____ proper names for building big project levels , you know you have seen these ~~big~~ color tanks / Now this color tank so the intersecting project level ~~tanks~~ technology to cover with the aero-dynamic requirements that gives you the cross breed that means for no weight loss in your structural shaping you can the full pressurized structure to your other demands That is then the old-fashioned reocket. Which has multi-cell fuel tank multi-cell lux tank which has vantarelel tanks instead of stacked up tanks with a big suction lines penetrating , you n know , we had

upper
the other tanks , the lower tanks the suction lines going through the tanks which is really a pain intthe neck. Here you have short suction lines you have a simple thrust structure you know, but this is improved maybesteered time rocket , this t is for the rocket people,. Then where the gimble turns off you have the main spaw , you attach your of your wings, now your wings this is the aircraft structure with effective landing gear and then you ha ve your engine package which is another inter-face package, and that together makes a re-usable rocket. You know this is before F-I engines that's good enough for the shuttle, this is F-I you can see if you t take hydrogen enginesyiu know they make sure little people or propulsion people, because propulsion was the major development here, for guidance and control people there were not many structural people involved, because everybody could do it. Now making that an aircraft it's different . If you want a propulsion point of view deceide for the best engene, and the best engine was the hydrogen fire engine. Thebn you disagree because hydrogen uses two and half to three times the storage volume its light and this is the se size of the _____ and this is the size of the orbitla just to get the hyd hydrogen in there . But if you use the fuel the kerosene which is 20
?????
times denser than the energy of the lux then your tank gets so small and your booster gets much smaller for the same se size. Taht means while here the specific impulse of the not-fuel engine is making 30% more this is the hydrogen engine your structure is only half s as big
and
and your structural savings ~~øø~~ the total operational behavior overides by far the selection of thepropulsion system form a specific interest point of view. Now if you see the whole thing that's what you get and what really happens is there's now a big cover on . . .

"That's what I'm gonna ask you because all the pictures and models

Ive seen are more or less these huge thing here rather than hte the lighter one but tey are coming around to this finally . . "

"Yes this is two years old but now it's really invented by everybody but I mean that they are not yet formed , you know we don't put out any configuration, you know we are a government agency and we just do the impossible and the industry does the posssible and we shouldn't really do the work of industries. And so the mode of operation is to wait until you get the responses you only fertalize finalize the idea by giving it everything you know until you get around to something which is accepted. And this interation and this ____ has been going onthe last couple of years we have spent several billion dollars just on the educational program . Which is the purpose of the NASA program I mean we are not building the vehicles just to play with them, I mean this is work and technology eh. . development reasons . So it's like a big monastary you know , you have really nothing accomplished you pray three times a day and while we pray in vl volume it's the same thing like l sticking you in the middle of an monastary and inventing the flight power because we have nothing else to do in between prayers. So that is deliberate . . people have to invent it up some way and after it's not satisfactory you just consume that is more satisfactory to create uh . . it's horrible if you just consume gasoline and car tires you know, . It's easier for people to a say I did my day's work and now I even pray and you are more satisfied fo from that, that's really the underlined causes, So I mean we have to create a program that has a large creative challenge and spread it out, and that's exactly what we are doing . So if you say that'sthe way to to go that's the old generation way to say it, you have to go through all thinkable considerations and do it the hard way. Because if you don't do it the hard way you are not learning anything. So this is the battles we have to fight. If we would say just tell us we can build a booster it's very similar to that one you know we might habe another SST program, It might not even be complete. But if you build up a national program for 20 billion dollars they effort is not bigger s as you ge t 20 million. So you have ot go out for a bigger package,which is much larger and much longer if you get that total it's more efficient as if you do in piecemeal. And we have to look at the totla thing , we have to think big and not just think in certain specific practical solutions. And if something is done the wrong way that is really stimulating technology because we are . . . . . because he didn't know that the holes were round so he put square holes in . Then the manufacturing technologists develop machine to make square holes you know with electro machines. So that was maybe the stupid portion of it but the next generation of engineers are using now the square hole in a very refined mode na and we have big instruments suddenly you know. And learning is only possible by doing something wrong otherwise if you know it alreakdy you don't learn anything. You know that the challenge and the solution overwh elm your capability for awhile and then the next generation of engineers and scientists they have enough reason to be creative and solve the problem. So if we don't have where the weapon system and development prog ram where we have to feel the need , we have the technology program where the space objective is only one of the re asons to develop the problems. And the problems must be very dimanding with respect to the solutions , and it must keep our nation busy. So this where you get to because it sounds pretty funny that I say we wouldn't know how to do it . And we don't have to say Monday on the booster you know . . . . . "