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Topics - Working w/ Corps of Engineers; evaluation of facilities; lump sum construction; master plan adopted; construction schedule; site & building elevations; minimizing air conditioning costs; Data Collection System (DAC); central plant; Design + AE decisions for Space Environment Simulation Lab (SESL); vacuum test failure of Chamber A; Bechtel suit; 3 years Stanley; controversy over use of concrete panels; Congressional budget & design; Contractor relations; relocation experiences & temporary facilities; Corps of Engineers lack of relevant experience; selection of Architect Engineer (AE); Luckman design; Brown + Root; land acquisition; Campus idea; funding requests; utility network revision; water supply; roads + highways; post-Carla visit impressions of area; master plan & changes; (OVER)

incremental buedy; ~~elimination~~ dropping
Corps Construction Contract, handle
in house; msc oversight of off-site construction at WSTF

Interview with Leo Zbanek
2/2/67

We awarded early in the summer, when I say we, I considered that since we were working so closely with the Corps that we were partners, of the Corps. I think that philosophy ought to be reiterated. a little bit. I had come from a missile program where the Air Force and the Corps were feuding violently and the product they turned out was a sorry product. You can't get work out of a partner by beating him over the head with a club and cussing him. As long as we were going to work with the Corps and we determined it was to our advantage to work out a system so we could communicate with them on a friendly basis, certainly not direct them. We were intimately associated with them - we lived with them. We - bear in mind the Corps had the prime responsibility, but every move they made, we lived with them. We essentially concurred in their actions and such differences we may have had, and we had many, these were differences of opinion. I disagreed with Col West on his decision for example to relieve the construction contractor's responsibility for hauling the material out of our big ditch along the west side of our site. because he contended it was better to leave it dry on the spoil bank and then haul it at a subsequent date rather than have it piled on the site and not dry very rapidly, and primarily because I felt credits we derived from such an elimination were too small and I disagreed very violently to his approaches. The contracting officer has certain rights and must have theright to use his judment- judgment. It was his judgment that this was a better thing approach. I could say I told you so in that case, however, he would probably say I told you so in many other cases when we disagreed. Each individual has his own views on how a contract aught to be administered and these contracts we were entering into had plenty of areas where interpretation had to be developed in their administration.

In disagreements - In this particular case, Col West for example issued direction to the contractor to dump the excavation out on an embankment and then permit other contractors to haul from that embankment and took a credit for the haul of a couple of miles. It was my contention that the credit that he got may have represented what the contractor had aimed for the haul but would certainly not be the equivalent of what we subsequently would have to pay for this pay so it was not to our advantage. It would have been better to have piled it closer to where we were going to use it The argument against that was that it would be i n the way. If it was put too close, this would have been true. We would have had mounds of dirt way too close to our job and it would have been in our way later as we needed to draw the dirt from it. This difference amounted to about $154,000 on this contract. At various points of difference, this one item of credit $154,000 were involved in this change order. Not all of the items were credit items. Subsequently GAO established we were right in th s case and they demanded that the contractor be back charged and the Corps has been exercising some gymnastics in attempting to collect from the contractor. I don't know whether they every have or not. It was established that our judgment in this case was valid. very well. I wrote a letter in which I used wrote the term that I was appaled at the decision position of the contracting officer, and subseq uently Mr. Hjornevik suggested that I don't use terms like that about the contracting offi cer. Being a hard hitting construction man, I didn't think I had to restrain myself, if I was appaled, I would be appaled. We could not have built these facilities without the assistance of the Corps. We did not have the personnel nor could we acquire them from other agencies at a rate

that would have permitted us to do this construction. When people imply that the Corps probably did do us a service, if they didn't it was our own fault. We didn't understand their methods of operation, we didn't instruct them, we didn't adjust ourselves, and mostly we did not have the capability of properly defining our requirements ~~as far as the overall competence.~~ I think the facilities we've achieved here are probably superior to any governmental installation as far as quality. The Corps over the years has been a construction agency and their philosophy of operation we are hiring competent construction contractors, We are handing them a document - plans and specifications - and we will only check on them after the job is completed to determine whether or not they have accomplished what the contract requires. This philosophy is good if applied to a conventional ~~builder~~ building, but - it falls down when it is applied to nonconventional buildings. The SESL, the Flight Acceleration Facility, ~~Any of the non-conventional buildings~~ - the MCC - these nonconventional buildings ~~while~~ we found problems in them when we attempted to use the Corps philosophy, ~~in that you~~ since we were permitting time to go by before ~~you make~~ we should corrective action. In areas where ~~your~~ plans and specifications cannot ~~so~~ be specifically defined, ~~things~~ or the contractor hasn't had experience under these conditions, ~~You are~~ specified specifying something ~~that is not~~ common, then ~~you do have~~ we had problems. ~~Here is where~~ the Corps tended to fall short of their ideal. This is precisely what occurred so far as the Air Force was concerned in the missile business. They were too close to an R&D program, The Corps, ~~as a~~ in their construction concept, ~~They are~~ were doing lump sum construction. ~~They will expand on that.~~ This whole center was built under a set of competitive lump sum contracts. ~~We had~~ I can't recall any exceptions. ~~I think~~ every bit of work was done under competitive lump sum bidding. When ~~you are creating~~ R&D facilities are created in this ~~and you~~

way, but at the same time we were
~~are~~ asking the construction contractor to ~~literally~~ do ~~some~~ research and development on a lump sum contract, ~~they are not consistent~~. The lump sum contract is one where the concepts are all firm, ~~and R&D not necessarily in that same category, but~~ the lump sum contractor who is successful has put ~~into~~ the least number of $ for the R&D effort. That is not consistent with what ~~you~~ the buyer may want in the way of R&D effort. Let's say piping systems, interconnecting vacuum systems, or cryogenic systems in the SESL. Here we asked the contractor to perform engineering effort to outline his test plan. Under a lump sum contract, he would outline what he considered to be standard, what he could get away with, rather than the effort that's necessary to establish the quality. ~~They are not consistent.~~ We had no alternative ~~course to travel.~~ Congress does not permit normally any deviation from this contracting form, so normal government facilities are not of this nature.

~~Back to the master planning. It is interesting to note while~~ Our original master plan contemplated a ~~multistory building for the~~ 14-story administrative building ~~14 stories high~~ - but when the original master plan ~~the one~~ was generated by the architect who ~~were~~ labored under the misconception ~~concept~~ that we could go to Congress and get our FY-62 program increased ~~so we had all the funds we needed for~~ to cover all our overall needs ~~in~~ facility ~~and that FY~~ rather than, in subsequent fiscal years, go back to Congress and ask for additional funds. The A-E's were Brown & Root, Charles Luckman, Bernard ~~Couch,~~ Johnson (mechanical work), one from Austin and 6 firms from Houston - all combined in a joint effort. Once it became clearly identified that the master plan was to cover a number of fiscal years of budgeting and the detail design to cover a smaller amount of budgeting, then it became evident that the multistory buildings that would cover more than one fiscal year weren't economical. It isn't economical to add 6 floors on top of an 8 story building if you can build the 14 floors at the same time, then it is economical. We had to change our basic concept from one of rather

considerable height to one that's spread around the campus area so you could economically add ~~in~~ increments. ~~That's probably the most significant thing.~~

We went from the 14 story to the 9 story (administration building) for the 9 was all we could afford in our $60 million budget. That's all that was covered in that budget. Subsequently we built a 7 story building, Bldg 45, as part of the master plan In our original plan concept would have been the top floors of building 2. So it's where similar space was added on the master plan.

~~I would think you~~ (we) (have) would gain some advantage by hiring one ~~t~~team of architects to do the master plan and another teamof architects to do the detail planning. ~~H~~ad I it to do over again, I would have 2 teams working simultaneously. The advantages of the single team concept ~~is~~ are lost as too frequently the designers find it too difficult to determine what portion of the master plan (thinking) that he just went through. We found it far more difficult to isolate that segment that has to be done ~~when~~ from the master planners think. (of) The Congress has agreed that the effectiveness of our master planning did result in some economy. ~~Next,~~ (also,) I think we would develop a preliminary engineering report for each building. (we extended this) as it was) We went into final designs simultaneously with the master p~~l~~anning. That meant ~~you~~ we were well down the road structurally and architectually ~~b~~before ~~y~~our mechanical and electrical concepts had been firmed. We lacked budget control with this concept and actually had detailed quite a bit of the building plans on too gradiose a scale and had to throw them away and back off and do them over again because we were proceeding on final designs prematurely. before our master plan was approved the AE had proceeded about one-third of the way on detail planning ~~of~~ the structures ~~the vacancies~~ we were going to b~~u~~ild and well beyond our budget. ~~so~~ we had to throw away master drawings and start off from scratch. (and last.) A preliminary engineering report is something

that's essential for each building ~~if~~ It would fit ~~to such an extent that every-one recognizes that the~~ room size as a functions within the building, giving relationship of the elements within the building, the structural framing, ~~the feature~~ and where interior parts are used for laboratory vs office space. All these things being firmed up and signed off by the user before we start on the detail design. This makes for economy in the designer stage. ~~also I think i would~~ In retrospect I have developed much firmer detailed schedules for construction at the early stages. The Corps had declined to develop detailed PERT diagrams. They thought this was the contractors responsibility. We differed with them strongly. Subsequently we determined it was to our material advantage to put schedule dates on milestones within the framework of the contract as well as at the end of the contract. This ~~to give~~ give us the right of entry to ~~put~~ install in GFE in order to insure that certain elements of the building are completed rather than wait until the last possible day to complete the overall building. To make these milestones within the framework of the contract, it requires a detailed analysis of what a contractor is going to do, when he is going to do, a detailed analysis of when he can place orders, and an analysis of the potential delivery date of the elements within the contract. ~~All these~~ things that it takes time to fabricate. The questions to be asked: When does the order have to be ~~place~~ placed? when can the equipment be delivered? Subsequently we developed far more detailed information and imposed on the contractor ~~as~~ a specific date within the contract ~~some~~ very early in the framework of the contract, and this gave us a little better control in a construction contract. I don't think the fundamentals of design from the master plan would have been changed very much. We have given some 50 different architectural teams an opportunity to review our basic standards, make suggestions, come up with ~~some~~ inputs, and we have had

some ~~examples of~~ suggestions for minor changes. You will notice Bldg 31 has a different appearance than the other buildings. The architect chose to put black columns down underneath the overhang and narrower black lines around the building. The use of glass on a rather high bay wall, particularly walls that go 2 stories high with dark glass for the spandrels. These changes we subsequently examined after we found that they did not offer the economy that we hoped to gain. ~~As a~~ In fact, ~~they~~ we didn't gain anything ~~by the change.~~ We ~~merely tended to estaboish~~ established that our basic standard originally was not too far wrong. In Bldg ~~45~~ 2 we moved a structural column; ~~from t~~ The column goes upstairs and becomes an interior column and bothers you somewhat in your placing of furniture for it becomes a column right in your office. We decided to make all the columns on ~~th~~ Bldg 45 exterior columns. It offered some advantages, we could bring the utilities right up to the exterior wall. Your telephone connections would come adjacent to the exterior wall and it improved some of our utility system. But the improvement did not equal the disadvantages created in limitations (they go at right angles to the wall and decrease visibility). ~~The changes weren't of material~~ advantage. The net result I've come to the decision that our basic design was not too bad.

~~With respect to the elevation~~, Carla came up to elevation 13' above sea level and ~~this~~ wind ~~now~~ of ~~rubbish~~ ~~that I described was just about at elevation 13' above sea level~~. Our site averaged between 16' and 21'. We elected to place the floors of our buildings at about elevation 20-21' and have a mound of earth at least 1' high to steep down from our buildings ~~and at least 1' of mound around each of the buildings~~ and then slope the ground as a grade from this podium which would drain water rapidly. On paved areas the minimum grade would be 1/2 of 1% and on earth areas would be 1% so we sloped the ground rapidly to a storm sewer system and then to a major ditch system of such size that we got rapid runoff of flash rains and we were well above

any known high water line created by the back up of tidal water. This was our basic concept for site planning. Our site being high enough to be above that. One of the first things we looked at as we paced over the site was our relative elevation compared to where Carla had backed up the debris. With respect to the wind was when we elected to go to a large amount of glass This did bring up the problem of what we were going to do in replacing the glass if we had a violent storm or what we would do to minimize the damage to it. We selected a window construction that provides for the edge of the glass to be surrounded by a rubber gasket. This gasket is flexible so the glass is not resting on the metal, but it is bound in with this rubber and it's a hinge so the glass isn't firmly held, but it is held weathertight. It may give. We actually tested these panels in a wind tunnel and under sand and water conditions. Under these conditions, this glass would stand better than 120 mile wind; loaded with 6" of sand, the equivalent of relatively high pressure 75# dead load and still not fracture. The windows themselves unless they are hit with flying debris will take almost any hurrican wind. Subsequently we found that they they were weather tight and proved very desirable. This was developed about the time we went into being and offered to us, and we did a little gambling with it, however, subsequently it has become standard around industry.

Two things were done to minimize the airconditioning load. The buildings are all oriented so we get the maximum benefits from our sunshades, at an angle to the road for a very definite reason. This gives us the maximum shade on every building and our buildings are normally what you might call east-west axis. The maximum amount of frontage is on the norht or south so we get the best shading effect. Those who have offices on the sunny side know this is a desirable thing. Then we tinted all the glass to get

~~the~~ a good view out, but essentially the least effect of the sun so ~~that~~ ~~every~~ tinted glass and the sunshades, as overhangs, give us the maximum amount of shade which had a profound effect on our central heating system. It reduced the load some 30%.

~~One other thing we did.~~ About this time we debated as to whether or not we would provide redundancy. These buildings are locked in. You can't live in them if the air conditioning system goes off. We had the choice of either providing a standby system to make the buildings usable or to put in a system we have with the ultimate in reliability. We analyzed the cost and found ~~if we achieved reliability~~, the equipment itself is ~~fix~~ fairly reliable ~~if you can~~ and it is possible to anticipate when it's about to start to break down. We elected instead of duplicating the equipment to put in a data collection system of the equipment going to a central point where we could watch each piece of equipment and insure that it is functioning in a normal fashion and determine when it starts to deteriorate so we could ~~take due~~ performance maintenance on it ~~then.~~ This data collection system (DAC) has since become famous. It's been reputedly referred to as the $1 million thermostat, ~~A and a lot of other things~~. But its prime purpose was to eliminate this redundancy. Normal buildings that you see downtown have standby airconditioning units because they cannot stand idle . ~~We did not and~~ We have had extremely good results with the DAC. It measures bearing temperatures, rate of rotation on the fan, the position and quantity of air, it measures everything going on in the system at a central point. It provides additional information if we find a pump or fan is going wrong, all you have to do is punch certain data requirements out and it will collect the data and give you the information on where the drawings are or where you can go to get the information to fix this. The data also provides what's necessary in the way of tools, and

what repairs ought to be done. So we do a lot of data on the system that has tended to minimize the operation and initial cost as well.

No innovation here really, but we had to make the determination that it was worth our while to go to a central system rather than go to an individual system. Operating costs are very high in a plant of this kind. We felt we should not be short sighted and go to the least capital expenditure, but should go to the least real expenditure, capital plus operating cost and our central plant is far more efficient than 50-60 plants in each building, and we would not be able to afford the operating costs now. It would be astronomic. But we chose the central plant and having chosen the central plant the chilled water system is not an innovation, but it leads to the chilled water system being a solution to the problem. It's typical here rather than in other areas of the country. In 1961 not every facility was being air conditioned and we had to face the fact that we had no choice. In Houston, you have to have airconditioning.

The next most significant thing was that the instructions given the Corps of Engineers were so general that there is some question whether or not BRN A-E who were selected to do the master planning and who proceeded with the design of the basic facilities work were simultaneously selected to do the design of the SESL which was also in the '62 budget. There was a good deal of question. NASA felt so strongly that it was a special facility that we proceeded to select A-E's ourselves independently to do the design, to assist us in developing a criteria. We had barely started in this area when the C of E said they felt it would be a material advantage to us to let them monitor the design and we and they together could better select the A-E so we developed a pattern then of a joint a-e selection panel; the C of E and

ourselves. The first selection was done exclusively by the C of E when BRN and their colleagues came onboard. Subsequently, after we had started trying to get somebody onboard to assist us and develop the criteria, we didn't know what we wanted and we accumulated all of our requirements for a space chamber and we didn't know we wanted to simulate an actual bit of the lunar surface. If you recall in '61 and '62 we had the AF had created a budget for a space chamber they wanted to generate, simulating lunar surface and all its attributes and that was budgeted at some $389 million. We had in our budget $21 million - and you can't get much of a space chamber with all the facets they wanted. The least we could cut down to at this initial phase was somewhere between $60 and $80 million + our want list. We finally whittled this want list down to a must list to some $40 million and we had $21 million to spend. We had a real problem and had to get some engineers onboard that would try to narrow this thing down and we joined with the C of E and with a joint team and decided to use an independent engineering team to do the design of the environment testing laboratory, contending that we would delete the activity of the BRN team who were then engaged in trying to get detailed design. In the spring of '62 when we were in the peak of the design effort, Bechtel Corp did a preliminary design report for us, and then they did the detail design, and subsequently these were the designs we had the problems with. The basic designs we were working with we had discussions as to whether this was going to be a rigid structure or one of considerable flexibility? We concluded there was little need for considerable rigidity, but I don't think that inclusion implied we were going to have such flexibility as actually resulted when the

~~The basic designs we were working with. We had discussions as to whether this was to be a rigid structure or one of considerable flexibility. We concluded there was little need for considerable rigidity, but I don't think that conclusion implied we would have such flexibility that act~~ we had the defamation around the door. Chamber B was relatively flexible but because of it's general configuration, spherical, and a segment cut out for the lid... and a matter of degree, its flexibility didn't give us any major problems. Rigidity is just a function, nothing is ~~extremely~~ rigid. really, completely. Finally after a series of presentations by mid-year got the environmental testing lab report concluded and devised a system for the reduction in the amount of solar simulation, the production of Chamber A and B, the size of the building and we created a series of elements that we could b uy for $21 million in our budget. These satisfied our initial requirements. We decreed that the remaining elements would come in upgrading as we went down a period of time and subsequently we upgraded by some $23 million ~~I think the~~ to about its present capital value ~~is~~ about $44 million, ~~now.~~ These incremental additions were in '63, '64, and '65. ~~The~~ We were well ahead of schedule on the construction of the facility. It had been done in incremental phases, the foundations, ~~the big vessel itself,~~ the chambers themselves, structural welding and the mechanical systems, ~~when a~~ vacuum test on the chamber indicated we had a considerable amount of distortion around the door. We had a 40' cylindrical section into which the door, which ~~is~~ has a curving or domed head, is placed and is ~~that~~ framed into a vertical cylinder that made up the door section. At this junction a lot of metal that carries the stresses around the big opening from the main cylinder, became inadvertently reduced from what it should have been. ~~I say inadvertently~~, the basic design included ~~followed~~ a error made by one of the top executives in the design field of the steel company. He just noted some figures down and the designers that followed

didn't both to check ~~this basic concept~~ these figures. Here is where the error had apparently occurred. ~~The~~ A basic error was made here in the quantity of metal that was applied was less than we should have had. We had distortion. Not actual failure, but distortion to such an extent that we couldn't mount anything on this tank where it distorted. It's a dangerous thing to talk about ~~where~~ who was responsible for the error of judgment, or where blame should be placed for this reason: The C of E' is suing Bechtel ~~and this suit can run on to some~~ for $7 million. As a professional engineer, I concur that reasonable precaution should have been taken in checking, by Bechtel. They engaged what they thought were superlative designers, Chicago Bridge and Iron, who had done a great deal of work in the design of special vessels. ~~That effort they felt,~~ In engaging the best they knew in the business, and insuring themselves that the chief engineer of Chicago Bridge and Iron was personally involved in the design, They had the best ~~of~~ Chicago Bridge and Iron and they believed this was enough. The C of E have a normal policy that ~~nothing~~ no work will ever go out without an independent check. ~~No structure will ever go out.~~ In this case because of the complexity of the structure and in the interest of economy, Col Kausch who had by ~~this '61 or~~ Fall of '62 replaced Col West, decided that ~~the~~ he didn't have the capability onboard. He felt it was questionable whether he should go on out and hire a competitor of Bechtel to check Bechtel's work. We now recognize this as a basic ~~area and we~~ error -- he probably should have. It took us quite a little while to discover what had occurred. However, having discovered what had occurred we probably went overboard in making the correction because then we said, if this is flexible we will not be able to tie things to it and it will adversely affect the columinarity of the solar

simulation. If you squeeze the walls of the chamber in and you penetrate the walls with tubes which are shoving light, you squeeze it in and that light is not going to be focused the same as it was before the pressures went on the exterior. The decision was made to set up a criteria of considerable requirements and that changed the basic design and it was no longer a flexible vessel but one of high rigidity. The metal you see on there, the stiffening metal, is not on there to achieve structural safety, it's to achieve a degree of rigidity that was not originally set up as a requirement. ~~In any event, to examine things in retrospect, in this area,~~ I think we all erred by not checking the drawings to a greater degree, and in assuming the design had been done by one of extreme competence. The criteria applied seemed to be perfectly adequate.

The next error we made grew out of the fact that we had proceeded down the line with a series of contracts. The middle contract, ~~we had~~ included foundations, the erection of the shell, and then subsequent ~~contracts a mechanical contract -~~ by the mechanical electrical contract for the interconnection of the systems. We were about 1/3 of the way through in this last contract when we discovered the shell had some flexibility too. It took us years to get all the stop orders out. In retrospect, we should have cancelled the third contract immediately, paid that contractor off for the work he had done, and readvertised after we d etermined what had to be done. But leaving this contractor onboard and adjusting this contract by ~~changing~~ change orders put us in a bad negotiating position . We'd have been far better off to have cancelled everything out, audited the man's books and stopped work.

We stood in the standby state for 1 year and we subsequently paid quite a little bit. It cost us $7 million for which the Corps they are suing Bechtel for. That's an undesirable state. We wound up not making any progress. Our contractor had no interest in proceeding and he was in an all to the good stage. Every day he wasted he got paid for any way so he working against us every move. It was extremely difficult to ever get him into the posture, to get him out of the act, so to speak. Then we had to generate a special management team to go in and attack the problem and run him out, ultimately. Hopkin This contractor was 3 firms, one from Calif, one from Midwest states.

Brief statements we developed in master planning. We got into some discussions. Actually the President Kennedy got involved in our master planning to a degree, President Kennedy. The clay products people felt very keenly that our decision to go to pretest concrete panels adversely affected their business. They felt we discriminated against them. You can't develop alternates, concepts, on construction plans, and once our concept had been approved in the master planning, we proceeded on this basis. They felt so strongly about this that they went to the President, and as an aside I couldn't figure out why how they were getting such information until I discovered later that/the one of officials of the Clay Products Association was a brother-in-law of Col West so he was getting informed of our as fast as we did and did carry good strong briefs to the President that we could save $1 million by going to brick. We subsequently proved there was not truth no validity in this statement. It was just that we could give them a lot of money and delay our ultimate construction by having bricklayers galore standing over this job laying brick. The bricklayers have never agreed with our philosophy. The basic philosophy we established that it was advantageous to the job to have the maximum amount of work done offsite and we offered them some ultimates alternates.

and they came in with some alternates that prefabricated brick panels, but obviously they were too costly. There was real pressure on this brick and we spent quite a little energy in refuting their claims. That's probably the main fact. I think the Clay Products effort was carried on independently of Congress and it was somewhat an exploration of.

If you analyze Congressional action other than the generalities with regards to how we were shaping up our contracts, criticism seemed to be on one of our earlier contracts for $21 million and the next one for the environmental chamber is another $21 million, rather large contracts and they did tend to go to the lowest bidders and they weren't Houston firms. The feeling I presume, although I don't recall this particular aspect, we are not giving enough of this work in small enough packages to take care of small contractor and subsequently we had any number of relatively small jobs, $1 million jobs, $200,000 jobs with packages broken down so we have had all sorts of contractors of every size and the A&E architect-engineers little ones, 5 man firms, 2 man firms, and 1 man firms - firms of all sizes. But in that first large everyone thought we had sold their soul down the river because we had the combine of BRW and they were going to do all the work. Subsequently people learned there was a fair share going to everybody and we scattered around. It was a normal development of contracting procedures. From all logic, it's a lot easier to work with a local concern either at the design stage or the construction stage than to work with a firm whose hqa are out of town. You get the top man on the job more frequently, you get the benefit of the top officers, and I would much rather have a local firm especially in the design area. We've developed in our A-E selection - we joined the C of E as partners of theirs in the A-E selection by 1964 budget we were selecting the individuals A-E to do a preliminary engineering report

in advance. By ourselves, we were preparing criteria and handing that criteria to the C of E and subsequently we prepared the detailed plans and handed them to the C of E, so we had gone through a series of cycles. Once, the Corps had all responsibility and we had bit by bit taken a portion of that responsibility back. We found too many people transmitting information particularly in the design area, is a problem. It is necessary, to be very close to the designers, and the criteria development has to be close to the designers. In the translation it looses a good deal and you wind up with a facility that doesn't resemble your requirements.

Leo Zbanek, as Chief of the Facilities Division, had certain responsibilities in connection with the design and construction of facilities at MSC. My initial visit to the site was generated as a result of a meeting that I held with Dr. Gilruth and Wes Hjornevik at Langley. An appointment was made for me to tour the site with the Chamber of Commerce representatives of Houston and it was late in 1961 prior to October, sometime in September 1961. that I visited Houston for the first time and I flew over the site and then drove over it. what is now our Houston home. As an aside, the members of the C of C who were on this committee were also officials in Brown & Root and we flew over the site in a Brown & Root plane, which is a little aside. In recognition of the fact that Brown & Root are and were then and still are a major constructors. construction firm and had the question that Brown & Root may not have a vital interest in building our site. Subsequently we learned that they had combined with a number of A-E firms and had made a proposal to do the design, and were successful. and They were selected by the C of E to do the design. It was a fairly large size plane that seated 18-20 people, a major twin engine plane, A pretty good sized modification of one of the smaller military planes about like a DC-3, but a more modern counterpart.

Shortly after we visited the site, I came onboard - about Oct 20, to make Houston my headquarters. By this time, Marty Byrnes had opened up a small office at Gulfgate shopping center. The Gulfgate shopping center people offered us a headquarters free until we could find space in which to live and we had a couple of desks there, some procurement people buying paper and pencils and getting started to rent space. Doing all the things necessary to create an organization. I reported in to Marty and pointed out a desk which I never found time to sit at, and started exploring the situation in terms of temporary buildings, whether they were feasible to modify into office and lab space we needed and trying to develop criteria to permit the architects to proceed with the design. During this period we will return to talk about it later. We rented the Rick Bldg and started remodelling it, almost immediately, the Farnsworth Chambers Bldg, Lane Wells Bldg., and we actually wound up with some 13 different sites - apartment houses. Any available space that could be found was picked up and it took an awful lot of effort on the part of Marty and his team. GSA was asked to help out and you will find they did a lot to help us. They sent a man down and subsequently when we moved in the Farnsworth Chambers Bldg we had a man fulltime. But their system of operation was one of the slower approach to the acquisition of space and we had no time, so we were a problem to them, and they probably will never forget us because of the speed with which Marty had to move. To get back to the C of E, I mentioned they were selected by Mr. Webb to be our constructing agency, and on the basis of a single letter to the Chief of engineers, which is just an outline of principles that we would like to work with the Corps, we worked out a working arrangement with the Corps mostly by letters of understanding, since we had no procedures on how we worked together.

Initially we discovered that the Corps had assigned the Fort Worth District Office to perform the services for us, headed by Col Paul West. They had done very little of high technical work. They had one or two missile bases. So their exposure to the type activity we were going to ask them to do was limited. They were obliged to staff up from the other Corps offices in the country and they got a number of people from the LA District generated for handling the missile activity for the AF. In their growth period, they attempted to do with their normal staff people, which gave us some problems, because we discovered we didn't speak the same language. As an example, - we indicated we had a fair concept of our criteria. We had an idea of what our requirements were. This implied to the C of E that we knew precisely what we wanted: size, shape, and all the functions of the buildings. Whereas in truth, all we knew was just a general configuration - the general size and scope of our ultimate requirements and we didn't know how much of this we could afford in our first budgeted increment. Because of this misunderstanding, the Corps awareded the AE contract to a group headed by Brown & Root, and asked that group to develop master plans, coincidentally with the development of detailed drawings. So in fact, they were proceeding and had gone well down the line with detailed drawings before the master plan could be reviewed and approved. That resulted when we had to redesign and reapproach the design on the facilities, we had to stop the designers and ask them to back track. This obviously was a misunderstanding - misconception on the part of the Corps as to how far we were along with our concepts. We, in fact, were perhaps years away from developing all of our functional requirements, and it was established later that we were adding to our facilities 5 years after we started. Budgeting on an annual basis. The master plan however, that was ultimately generated did provide for the orderly placement of subsequent

facilities. Mr. Col West named a person named Martin as Chief Engineer and we created a Corps Office right in the Brown & Root office building, so we had the quickest flow of information from the Corps to the architects., which seemed to us to be most desirable. If we had a long communication line, we would never get any drawings done. Our problem was in generating a communication line from Langley to the Corps, and the first few months were literally spent in trying to develop this communication line, Trying to determine what we really needed, what we wanted the Corps to do, what should become the first element of design. We had an approved budget of $60 million, and the facilities described in that budget were basic administrative facilities and a basic element of a space environment simulation lab. An analysis of the master plan as it was developing indicated that it represented $175 - $200 million worth of facilities, so it became evident that we either had to go in for additional funds in FY-62 to make up the deficit or we planned on incremental funding of the additional facilities as years went on. NASA's experience was that it was far better to incrementally fund these facilities. They determined this was the manner in which they were going to do it. The Corps on the other hand, Col. West, very firmly felt that we should follow the course of admitting we had $175-200 million worth of facilities and go to Congress then and get the $175 million, and build them all in one fell swoop. We finally convinced the Col we weren't going to do this, and this required a reapproach to the AE contract that had been entered into with Brown & Root and Assoc. Reapproach to the point that we had to tell them to stop designing buildings that weren't in our $60 million budget, They were proceeding with their plans for buildings that weren't in our budget.

This redirection cost us some time and some dollars ~~as-as-~~ (about $800,000 in wasted engineering costs). A portion of which we ultimately recovered in that we had preliminary plans that had some value as we later added these buildings to our complex. But the energy expended in getting that back on track was quite significant. A good deal of the relationship we developed subsequently with the Corps finally came from them recognizing that they had some responsibility to determine what we wanted and some responsibility to attempt to achieve our desires within the framework of their organization merely to shrug their shoulders and say we didn't understand you but you still are obliged to pay the bill because we are off on a tangent does not make them a very good agent for us. We had some little problem in getting them to understand that they couldn't go off on their own. To back up a little -

Some of the philosophy of our site development and how generally we evolved the things we see here. The C of E were selected to be the managers of our Engineering and Construction effort, and at this phase of the game, their A-E selection panel had the responsibility of selecting of the designers and master planners of our center. We were curious to know how this panel would function and we had a vital interest in who was selected. We asked to observe the activity of this selection panel and Mr. Campagna and I sat with the Corps and watched them review the brochures of various architects and the combines that were formed, once publicity about the Center was general. We sectionally concurred in all their actions. We made no comments, but we could see the action was done not in a capricious or arbitrary fashion and it was an honest attempt to select the best qualified firm. The arguments for the selection of the one ultimately made were valiant with the background of construction that Brown & Root had and a very substantial group

of consultants. they had selected. They were an overwhelming choice and it seemed logical that they should be able to tell us the cost of the construction that was going to evolve and with their national and local architectural support give us something that's attractive, well planned, and well developed. For example - They had Chas Luckman of LA as a consultant on the master planning, and Mr. Luckman is an extremely capable individual and a very well rounded qualified firm in this particular area. They had at least 5 well known architectural firms of Houston and Austin on the staff so we had a well rounded engineering group, that selected the mechanical firm, to do the mechanical work so that in addition to the Brown and Root capability, they had supported themselves with an adequate amount of support so they essentially taped talent all the town that could be made available in the area. We had little Our concern was not that we didn't have a good capable firm, as certainly with the leadership of Brown & Root, was able to furnish the necessary leadership. however, we had a good background but one that had not been primarily interested in developing Architectural engineering drawings in the nature we wanted one to go out in competition so we did have some But we were concern about their ability to would have to be adjusted to suit our particular requirements, and That's why we asked the Corps to create an office right here in Brown & Root's office here in Houston. Very early in after the award of the contract to Brown & Root, which this must have been early November, we met with representatives of all the A-E firms in Ft Worth at the C of E's office. In mid November We had what might be called a pre-design conference, a conference in which we outlined our viewpoand objectives and stated what we thought was the status of our criteria development and tried to put them and start them off on the right track. foot. I think this conference occurred in mid-Nov, I would guess it was before Thanksgiving because it was shortly after Oct 20 which is my first meeting and about the time we went to Ft Worth to talk about SESL.

By mid-Nov we had the firms all collected. We indicated to the architect that we contemplated building more than the 1,000 acres that had been offered us by Rice Univ in this west part of Harris County. Rive- Rice Univ had been given this 1000 acres of land by Humble Oil Co contingent upon its being used for purposes such as for MSC but xxxthis 1000 acres provided a limited access to the only road then usable, Farm to Market Road 528, (subsequently changed to Texas Hwy 1). 528 was a 2-land road that went along the Lake, had been destined for improvement and improvement had started at Webster to widen it to at least 4 lanes. - so it was scheduled for widening and seems like reasonable access. Our master planning group of a handful of people, Jim Bane, Welch, Helson, Campagna, and one girl. We had 4-5 people in Langley charged with the responsibility of collecting the requirements from the various individuals there, some 700 people in a cadre coming down here. But looking over the 1000 acres and the requirements, and judging the basic potential we felt it was impossible to build on the 1000 acres with only a 200' wide access. We decided we would have to buy at least another 600 acres to give us frontage along FM 528 of sufficient length so we could bring in a multiplicity of entrances. In addition, to that, it would be desirable for us on the other borders of the site to have at least 2 more entrances and subsequently these went to Clear Lake City. With this basic criteria, we went to Dr. Gilruth and he concurred, and we recommended the procurement of another 660 acres before we would attempt to build on the Clear Lake Site. We briefed the architects of the potential of increasing the size of this site and indicated to them that since we were rather late in getting started with these plans that the buildings ought to have elements that were prefabricated to the maximum degree possible. With as much energy applied off site as possible so this precluded by basic definition the use of extensive brick masonry walls, it precluded to a maximum degree tile

partitions inside the building ~~versus sheetrock. The~~ sheetrock by definition ~~was more of a~~ prefabricated and done off site. One of our criteria was ~~to~~ minimize onsite labor and ~~this to~~ insure ~~we can build~~ rapid construction. ~~When we were interrogated about~~ what the complex ought to look like, we ~~said the only way we could think of it was~~, it ought to be an environment that would inspire ~~the~~ developmental thinking of the people ~~there~~. It should not be a factory type of environment, it should be an inspirational ~~type of~~ environment. We want ~~to push back~~ the frontiers of science, ~~we want to gain ground,~~ to stimulate thinking, ~~and~~ we had been through ~~the~~ cycle 10 years before of blank-walled buildings and felt these had failed from the inspirational stnadpoint, ~~and~~ we needed glass walls, vistas. We describrd this as being somewhat of a campus like atmosphere versus the industrial lab. ~~And considered in view of~~ the fact that ~~this~~ was at one time levelled off ~~so it was~~ a rice paddy, that we should develop architectural features during our construction period which would change the contour of the land, ~~so~~ we proposed that ~~they dig~~ drrigation ditches and use that dirt for making the necessary fill. We proposed that ~~they would put palms~~ as architectural features, rather than ~~to~~ disguise any bodies of water as ugly storage ponds. ~~Subsequently we did~~ we had the ~~xx~~ mall planned with 3 lakes, ~~The~~ walkways ~~planned to~~ surrounding them, ~~these and to permit travel around these lakes and literally to keep the lakes relatively free, they took~~ the dirt out of the lakes and ~~brooked the~~ contours around the malls, ~~You do see site~~ changes in elevation ~~as we go~~ around the site, hills and valleys ~~that are~~ created both for esthetic reasons and to ~~get~~

provide slope ~~drainage~~ to ~~the~~ our storm drainage system ~~we have.~~ Obviously ~~when~~ as the original site was as flat as a pool table, when it rained, water stood on every square foot of it. ~~We had that problem.~~ We established, for example, that if we are going to carry a significant quantity of rain/water on our streets they have to be hilled and valleyed, and that's the reason when you drive down the streets you see it undulating like a rollercoaster. ~~This is to~~ It provide the slope to drain the water to the stormsewer system. Otherwise you would have to parallel the streets with stormsewers and increase its cost. ~~But this undulating pattern all generated by dirt being moved onto this level plateau we had.~~ We were fortunate in that the level plateau was above the highest water line that Carla created. ~~It was interesting as we flew over the site,~~ Carla had created a debris line ~~and floodwater line that went to~~ about elevation 13. Our site is predominately above elevation 18, the floors of the buildings being elevation 21 or above. ~~So that gives you an idea -~~ We are about 8' above the highest water line that Carla generated and in almost every instance, our utility systems are above that high water line as well. ~~Our utility systems.~~ We talked some in our preliminary meeting with the architects about ~~the~~ site development, concerning ~~The~~ advantages and disadvantages of utility system under a covered walk system vs ~~the~~ a utility system in a ~~utility~~ tunnel. ~~When we talked of the campus development, the possibility of~~ In creating all of our major structures in a loop or about a loop, ~~which~~ would permit us to join these structures with a utility tunnel. ~~so we could~~ It would also enable us to use the ~~economic advantage of a~~ central heating and cooling plant ~~was fairly well established.~~ to economic advantage. This meant we would not be able to disperse our buildings ~~were not disbursed~~ over the whole 1600 acres, ~~but~~ Instead we were held rather tightly in the middle ~~270 acres or~~ to 270 200 acres and the out reaches were used for the more noisier, hazardous, ~~or~~ facilities ~~that required dispersing, while our primary~~

elements were created around A close knit mall had 2 advantages. It permitted a reduction in cost of our utility interc onnection system and also permitted us to plan these buildings so normally you would walk from one building to another and normal communications would be by people walking around the mall. You could get to the cafeteria without having to get into a bus. This had a rather significant effect on our plan. After we left the architects, they proceeded to develop the master plan, They also proceeded to develop preliminary drawings on detailed size sheets on all of the buildings they were master planning. Their concept being that they had a contract not only for the master planning of the entire ultimate Center but for the design of the ultimate Center. Within a few weeks we discovered this was going to be a problem in that they were working on facilities that budgeted 3 times as much as we had and finally we convinced them we had to gear ourselves down to the $60 million we had in hand all the money Congress had given to us. This occurred, we saw their budget figures and the trends they were following about the time they completed their initial submission on the master plan. We decided to present these factors to our Hqs people. First we went to Langley and outlined to Dr. Gilruth, Mr. Hjornevik and the staff at Langley our developments. This occurred shortly after Christmas. We had been engaged about 1 month when we were able to get some measure of where we were heading, At the end of this 5-6 weeks period, we presented the first portion of a master plan. This indicated some very lovely structures. Every office under this master plan concept either faced to the exterior under landscaped or into interior landscaped courtyards. The labs themselves, were somewhat isolated from the administrative areas, Contigious to and removed by courtyards from the administrative areas. We soon saw as we examined the preliminary estimates these were far too costly

as a design concept.

~~a structure. To create~~ A courtyard doubled the amount of exterior wall space; our A unit cost ranged from $30-$40 per sq ft ~~and this was~~ excessive for government facilities and more than we had or felt we needed to spend. We then asked ~~The~~ architects were asked to reapproach this. Before doing this we went to Hqs to get Hqs approval on the basic principles we were involved in. We made a presentation where we stood, how we were approaching it to Hq and the general architectural concepts were reviewed and approved at Hqs with a confirmation that we should ~~d~~iminate the courtyard concepts and reduce these and improve the efficiency of design to the point that we had more moderate unit costs, we should also ~~and~~ limit our activity to that portion of the work that ~~we~~ could be accomplished within ~~limit~~ our approved budget. So the master plan was revised. ~~Back up~~. We went to NASA Hqs ~~and~~- in late Jan. The presentation was made initially to Mr. Webb and Mr. years. Seamans. The briefing was mad e by ~~the LA master planner.~~ Mr. Luckman who did a very fine job of outlining what he felt the architectural objectives were, ~~and specified~~ our views and ~~gave a great argument~~ He stressed the need for the courtyard concept. But when ~~they analyzed the overall~~ budget ~~and the prlblems they presented to us for achieving our facilities~~ costs were measured against constraints, we found that the Luckman approach would use actually we used up the $60 million ~~merely~~ in housing administratively our people without building any labs. This was impossible ~~for~~ us we would have had to go to Congress for more funds and NASA had committed themselves to a philosophy that they would not ask for money this year, it would employ the ~~they would wait until next year~~ - incremental funding technique. It meant that we ~~either~~ would have to delayed the start of our facilities to achieve the courtyard and Hqs agreed with ~~Langley~~ and our MSC ~~group there, and it was most unlikely that we would want to go this high.~~ people that the advantages of this design were not worth the cost. We ~~charged~~ asked the architects to return to the drawing boards ~~and redesign these facilities~~ and come up with something that would fit our budget. ~~and they did~~ - Instead of ~~the~~ courtyards, they developed a layout where ~~that space in the interior of the building with the labs and g~~ ~~enerally speakin g you will find that~~ the administrative wing wraps around the la

The interior space is small lab or it is used for utilities, the distribution of services. But by changing this court arrangement we were able to drop our unit cost down by about half and we subsequently found under competitive bidding that we were building our space here for abour $20 per sq ft, this and air conditioned buildings/that we had a fairly good design, modular in design, We used standard details of modulized design 4'8 modules, and precast panels and wall structures, steel frames, metal deck, and light-weight concrete roof deck built-up roofs, so we were able to achieve buildings like the administrative building, Bldg 2 at just slightly over $20 per sq ft which compares with the $35 sq ft that Humble Oil spent on their tower Building in Houston. It compares very favorably with the lower cost of the b ildings being built in Houston. You have to compare the unit cost of a building in the environment or area you are building in. You can't compare our buildings with those that required in Wash. With this revised design, we were obliged to make revisions to the network of utilities being planned. We had been pressing in parallel operations the utility net separate from the building design so we could come out with utility network as rapidly as possible in the contract. We made some modifications in the drawings and subsequently we changed by change order the utility net as the buiding plans developed and we awarded the contract, the Corps, did the latter part of March and Work started March 29, & ground broke and work officially started April 1 on the roads, bridges, and the irrigation ditches, a major portion of the rough site work, so by April 1, and bear in mind this is a relatively short period after we got back from Wash since we were up there the first of Feb and you have to advertise these contracts for about 45 days, so they had very few days to correct these and subsequently we had to make some changes, but it took a change order, but the decision to proceed with the road net and the bulk of

that work with a very ~~good decision~~ sound. It ultimately proved to be one of ~~the better bits of judgment in~~ the best decisions we made, as it enabled construction that we did have some place for our activities to proceed in an orderly fashion. ~~Subsequently~~ Building was not hamstrung by ~~a mud path in which we had to~~ having to haul all of our materials over and we were able to proceed in a ~~fairly~~ reasonably orderly fashion because we got the road net underway early.

Part of that road net contract also involved the moving ~~of the irrigation or the drainage ditch as a~~ the water cooling canal from the Houston Lighting and Power Co that went through our site. ~~and~~ One of the reasons we asked for the additional 660 acres was to ~~insure we had the right~~ be able to move this canal closer to the main access road ~~and~~ & get it out the way ~~xx~~ of our main construction, ~~pattern. We found that~~ our ideal location for our headquarters, Bldg 2, ~~the main office~~ was directly on the canal and it would have been the bane of our existence if we hadn't relocated it. ~~We relocated the canal having achieved the right by buying this additional acreage. We got that relocation in the original contract. We got a lot of things out of the way~~ - bridges along the contract. You can we could use the canal, but ~~bear in mind the cooling water~~ is salt water and ~~it's not desirable use for irrigation and~~ to get it into ~~xxx~~ our firefighting system would mean we ~~had~~ would have to purge the system subsequently ~~and we never overlooked the opportunity to~~ although we can always drop a suction line into that canal in the event we were desperately short of water, but our ponds are filled with fresh water and ~~here's where~~ there is we would normally tap ~~for~~ emergency. That fresh water is far better for us to use on a fire and it is handy. ~~Just put the pump down in and~~ They can provide us with ~~1 million - rather~~ about 3 million gallons and it's much better than salt water. ~~Speaking of water.~~ In that first contract we also had to get our water wells in. We drilled ~~have a couple of water wells some~~ 8-900' deep. They ~~go to a typical pattern around here that gives~~ get us about 1000 gal/min

of water. It's a fairly good ~~supply free of salt. Fairly good - I'd say any well supply~~ well. as we get more thickly populated ~~is in jeopardy and~~ we ~~were~~ expect ~~interested that we have an extension potential on our main system~~ to hook on to the main system of Clear Lake City. At some future date ~~and~~ they in turn have the potential of hooking on to the Houston municipal system so our water supply can be assured in the future, ~~should our wells give us problems, but~~ as it stands ~~right~~ now, we probably have 15-20 years supply of uninterrupted service from our wells without any concern. ~~We do have the ace in the hole.~~

While we were ~~talking about~~ planning the roads internal to our site, we were also working with the local officials ~~on trying~~ to get access roads adjacent to our site. We started ~~early~~ - early in '62 working with the county and the state trying to get access roads. ~~I only mention this because~~ these are just coming into being now in '67 and '68, so it indicates the difficulty ~~problems generated in getting the state and country~~ The state and the ~~country~~ county felt the Fed Govt ~~must commit to these access roads~~ should build them, and the Fed Govt felt they served adjacent communities equally as well so it should be a state responsibility ~~- they provided access between communities~~ and it wasn't the fact that we were adamant but we found ~~no~~ There was consequently no way ~~say~~ we could make major contributions to these roads under the framework of Fed aid other than through the Fed aid road funds, and these were committed for years in advance ~~and~~ It took quite a while to get a recommitment and get Bay Area Blvd built for example, ~~and connections made to Bay Area Blvd~~ to get Hwy 3 widened, ~~and that planning accelerated and~~ to get ~~Gulfgate~~ The Gulf Freeway widening accelerated and an increase in the number of access roads. ~~All of this was an activity~~ We generated ~~in~~ this activity early, and ~~required~~ put sustained ~~effort,~~ pressure on both the county, ~~pressure on~~ and the state, both bodies were most cooperative, but handicapped by ~~again~~ a lack of funds. ~~and~~ As a result we had to squeeze our way into rather crowded ~~schedules.~~ highway construction programs

~~In terms of our master planning and how effective it was.~~ We had $60 million in FY-62 funds ~~and the initial master plan indicated~~ that with our revised unit costs and ~~a~~ new concept, ~~about~~ we could achieve our gross requirements for something under $200 million. A master plan was generated showing the location of all the buildings around the ~~xx~~ mall and on the ~~finer~~- fringe of our site. ~~The art work was produced and you will find it interesting that~~ that art work which was produced in the spring of '62 very closely resembles the actual photographs we see of our facilities ~~in that are made~~ today. ~~Indicating that~~ we had a great tenacity of spirit ~~to stick~~ and stuck with the plan or ~~that~~ it was not a bad master plan, and I am inclined to believe the latter. I think it was a pretty good master plan. ~~Develop our basic requirements and as xx other architects have become involved, they have looked at the pictures and found it xx=not quite that bad or why some of the decisions were made, I think one ought to review the first impressions of the site. The pasture, it had not been used~~ for rice growing ~~for a number of years, for they had pastured cattle in it and it was not~~ very heavily used, so it was fairly weedy and ~~as I mentioned,~~ level as a pool table. ~~Fact of the matter, on looking at the contour map that had been made, the Corps had,~~ I drove ~~on~~ to ~~the site and~~ the highest spot indicated ~~was a mudhole in which I~~ got stuck ~~with my car.~~ and ~~it~~ left a very poor impression. ~~Flying~~ Flying over the area ~~shortly~~ after Carla ~~and Carla occurred~~ in ~~Aug~~ Sep '61, the debris line was readily evident. ~~and~~ It was a depressing ~~thing in that you saw~~ sight. masses of rotting timber and brush everywhere. ~~Fact of the matter is the old house, West Ranch, there~~ was a debris line ~~that~~ went right through the mudlake adjacent to the property ~~and there was a fair size~~ 30' motor cruiser bashed in laying on its side ~~a real depressing sight.~~ Buildings, ~~p~~ieces of

buildings, telephone poles, and trash was everywhere. A good deal of work was expended to clean up this debris. We saw it and this gave us the first impression and following Carla things were bleak. Tree branches were broken and drying and as one drove you drive through the woods, you wouldn't get the there was little impression of life; it everything was more of death so it was not an imposing sight nor locale. Webster seemed dead and on top of being somewhat was a gloomy little city, the main street was torn up, and with its to get a decent base, they had dug had been dug a hole in the center of the stree t about 5' deep and were hauling the dirt was hauled away, so this was probably the worst looking paving you we had ever seen, in your life. In general everything was most depressing and to face building a mjaor center here was certainly no mean task. Almost any other site would have been more appealing, and I can say that. Probably the only thing to commend it the region was that it was potentially a decent recreational area, and it was fairly evident that it had had some significant recreational area, and we had acreage on which we could do something. My first thought was that the trees unfortunately we had on the site were located ikn the wrong place and we should start our first move by transplanting trees from where they were to where we needed them . We tried to do this and I made some suggested overtures to the engineers this to the Corps and they to the contractors, but we found the cost to transplant these trees from one place to another was greater than the cost of buying trees that are located about to be destroyed and moving them over on to our site was cheaper and the cost of growing trees and transplanting the growing trees is much less than transplanting fullgrown prees. to the point that as a result we did not literally transplant any of our own trees. We left them in our cleared forest. As a result of this first impression, I think this tended to influence the buildings design. you see. The demand came that We had to have landscaped areas to look out on because the site was so bleak. So we immediately planned on some landscaped areas using natural beauty. As far as we were concerned, there was none evident. It has subsequently grown up

and it's not so bad, but then it was not evident so we had to
Further than that it was such a bleak atmosphere that this tended to
influence us to very light colored buildings. This may have been one
of the factors that forced us into the white and black contrast on our
buildings rather than the cream colored buildings with blue trim or some
other color scheme. But the sharp contrast seemed essential and the
bright white was a desirable thing and actually in the warmer climates.
it's a highly desirable thing for us. I think the emotional impact at
looking at this area shortly after Carla was quite significant. Anybody
Anybody who ever came down here, I am sure felt the same way. I don't
think any of us after we've lived here for a while regret the fact we
did face up to building the center here because the environment has
with us being here met all the potentials that we could barely see under
that debris. I'd hate to have the Chamber of Commerce get that impression
from me now. Our original plans contemplated about 3000 people at the site,
so our original buildings, labs, etc., were only covered about ½ of our
ultimate needs. Subsequently we discovered that nowhere in our original
concept had we enviri envisioned housing for our contractors. Yet, service
contracting became fairly evident as a necessity when we analyzed our
potential maximum personnel level and saw there was far more work than
we could possibly do within the framework of civil service employees.
Yet, basically all of our thinking, original planning, budgeting, etc.,
had contemplated only those housing of the civil service people, and the
contractors would work elsewhere. It's evident you can't isolate all the
contractors, some of them serving within the labs must be housed in the
buildings. This changed our thinking and master planning concepts slightly,

However, not but so significant that we had to abort the general plan, as I mentioned. Our buildings fairly resemble the concepts we had. Under this concept, if you note we have an administrative headquarters at what we call the main entrance and near it we have those facilities that are generally used by the public - the Auditorium, and the cafeteria, and we go out in a coun terclockwise direction and we have a group of buildings that serve for the astronauts, their training and development, we go into at 12 o'clock at the north end of the xx mall area are the support facilities - buildings that deal with technical support, facilities. In this areas where we can make things laboratory and have our technical photographic elements, where we make things in shops. Then we go into the more massive simulation facilities where we can simulate space environment, or test devices under sound, or pressures, perhaps a little more cumbersome test facilities. Then we had the data acquisition center and the communication and allied electronic devices development at the southwest quarter of ht- the site. The master plan was essentially developed in this pattern. You notice I did not mention Mission Control Center. Subsequent to the development of this concept, it was determined that as long as we were going to be running significant length of flights that the control of these flights should be from the Center, and the MCC, a significant sized unit, was inserted in the master plan at about 10 o'clock, and because it did close to the data center, and in its mass suited the master plan environment best there, relatively close to the heating and cooling facility, it had a considerable demand on that, close to the north end of the site so the power source was convenient, and its insertion in this environment provided the best possible integration in the master plan. This actually you see the early art work did not show this building and subsequently you find it. The art work introduced the MCC into the master plan. xxx We were adaptable and

and I think you will find it and the LRL at about 1 o'clock in the master plan concept is are consistent with our ultimate master plan in that it they provided for a facility closely related to the astronaut training, and development and their care and it fit into the complex very logically in the space provided. You will find similarly with our in planning loop of streets outside the basic buildings that you can develop area we allowed for development additional buildings outside the loop (streets such as you see with still bldg 14, the radio range development bldg, or with later developments in '68 and '69. buildings outside the loop still close enough to their functional relationship with the other buildings for astronaut training for example and the electronic development area, so that the master plan lends itself to a considerable expansion and development, and It has survived because of this. We have always contemplated another buildings. bldg 17, contemplated for example in the electronics area which would have completed this complex, and it has been in every budget since 1964 and in invariably was it is left out. It is one of those marginal elements which we feel within our master planning complex that we need it desperately. It rounds out our capability, as it gives us the chance to create a source of standards, and it would be our standards lab, as well as a chance to it would add to our capability of doing microminuterization, etc., but mostly it would relieves some of the extra load within the center because we are mislocating personnel at the present time. They are not completely related to the functions that they perform, and They are seated in the wrong place in many instances and We need space. We are under built at this time. We have more people on the center than we should have. The center was- original designs contemplated 120 sq ft average per man. We are loading the buildings up now so I think we are averaging something substantially less than 80 sq ft per man, and in some areas, we are actually packing people in so they only can occupy 43 sq ft on the average. We require nearly 3 times as much space, or in the case of extremely heavily loaded building half agai

as much space, to get the standards we hope to achieve. What we hope to achieve and really need are 2 different things. The standard one hopes to achieve is an idealistic state and I don't think there's an office building in Wash that actually achieves the idealistic state, nor do I think you quite achieve this anywhere. We are overloaded and we could stand very nicely Bldg 17 to relieve this load. Our With each years' additional buildings as we add to the plan of capital improvements on the site, we also add to our heating and cooling plant. This rather ridiculous situation derives from the fact that if Congress gives us money for programs, it also requires that we have the related support, with that program so we rarely have an opportunity to build a plant for next years' facility improvement program. This is not the practical thing to do. From our standpoint it would have been ideal if we could have built a heating and cooling plant that would have suited all of our requirements for the future, but this would have entailed the risk that we never would have built the buildings to correspond to them and we would have had an extremely large heating and cooling plant and nothing else. We elected to do this building by increments and the way it's planned, these increments are just added features, you add a boiler, a chiller, or compressor, or what have you, take down the end wall and move it out by 50' and put it back in again. We've done this 5 times. It begins to wear out that end wall, but this is consistent with the manner in which we are given our funds and our approval, and with the ways we are ordered to do things and it might not be the most efficient thing, but we have by standardization of the end wall and standardization of our construction managed to make it something less horrible.

In our master planning we needed ~~reliable equipment.~~ highly reliable equipment. ~~As you know, you~~ We couldn't live in one of our modern buildings where we have no exterior ventilation. We seal the building ~~up like a tomb,~~ and provide air either heated or ~~cooled,~~ completely airconditioned, as necessary and we condition it because under the normal exterior temperature conditions, there are only about 5 days a year that ~~you could~~ we can live without one form of conditioning or another. ~~You~~ We have to dehumidify, ~~to chill,~~ or cool or warm all the air in Houston or ~~you~~ we would never survive. ~~Recognizing that we sealed our buildings in,~~ the windows don't open, and once ~~you shut~~ the doors are closed we ~~you've got~~ had to provide a mechanical system to deliver air. We had the choice of either putting in a redundant system ~~so you could always work in a building~~ or ~~put in a~~ highly reliable ~~system. Reliability must be assured and~~ the only way ~~you~~ we can assure reliability is to measure every activity on the system and determine when something is going to break down in advance and fix it before it breaks down ~~or you can just start repairing from the instance you start in, but you know whether you are taking out a good part and putting in a bad part if you repair without some pre-knowledge of what goes on.~~ Because we wanted a highly reliable system and couldn't afford a redundant system ~~for obvious reasons. A redundant system~~ we elected to measure all the activities on our system. We measure these activities by any moving part - such as a damper that opens and closes, or ~~any moving device we measure.~~ We developed a system of data acquisition. This resulted, ~~although we spent a million, it resulted~~ in a substantial capital savings. Also in connection with the planning of the site development, we discovered we had to own our electrical switch gear rather than to have the utility company own it. In some areas the utility companies own this gear, but ~~in this environment~~ here, the Houston LIghting and Power, sells power at ~~the~~ a wholesale rate at high voltage and the transformation

and the gear that switches this power is owned by the industries or agencies. We thrashed around for some time before we were willing to commit $600,000 of our capital improvement money, ~~for this thing~~ because ~~obviously~~ when our budget was made out, we didn't think about this. Our budget was made out before Houston was selected as a site. It was made on a premise that the site might be anywhere in the country, and it was a general budget and had broad aspects. I understand Messrs. Byrne, Hjornevik, Whitbeck, and a couple of other people sat down and brainstormed this budget into existence in one evening. This might be an interesting historical sidelight. - the amount of energey that went into the initial budget as compared with the energy that ~~goes in~~ went into any subsequent budget. Subsequent budgets we didn't always have the great insight that these gentlemen provided at the start.

~~It might be interesting to note that~~ Over the years our relationship with the Corps tended to change. The first evidence of this came from the fact that we wanted to select the A-E for the Space Chamber preliminary studies ourselves, ~~and~~ had proceeded with a selection process when the Corps discovered we were engaged, ~~in this~~ and they raised their eyebrows so high that we stopped ~~that action~~ and joined with them in a joint action. ~~We developed a~~ joint A-E selection panel and on the basis of that joint panel we selected Bechtel Corp to do the preliminary studies and subsequently ~~they did the~~ detailed designs. As we went along, we saw that the Corps needed some firm guidance in the way of criteria development documents or our communications during that hectic period when we were trying to develop preliminary designs had to be improved. It was almost impossible to get a good communication line fixed if ~~you~~ were changing architects as we went along. It was to our interest to get the maximum amount of participation by the

architects, ~~in this community or elsewhere for that matter.~~ We wanted to get the best possible architectural advice, and not to have all our eggs in one basket. ~~The maximum amount of participation on~~ this design so that almost ~~each~~ every major project that went out for design, we had an independent architect engineer selection and we select ed different A-E's, ~~to do~~ this. In any one fiscal year, we might have 5-6 architectural firms working simultaneously on ~~5-7~~ as many different projects. That meant we diluted our ability to communicate with them ~~20%~~. Our communication lines had to be improved. We decided we would develop what we called a preliminary engineering report that would furnish a clearly and concisely ~~hand to the Corps a~~ statement of our criteria - what we thought were the important things in the design of a building - attempting not to tie the hands of the architect but to give them instructions. We began to engage architects directly with the preparation of the preliminary engineering reports. ~~These -~~ The first one was for Bldg 45, an office bldg, which we wanted to impose on ourselves some added restraints, we wanted to improve the Bldg 2 basic concept, so we thought, to give ourselves the maximum lattitude in the way of design of a flexible airconditioning system, and we engaged a firm to do this preliminary report and we handed the report to the Corps and ~~said -~~ instructed them to Get detailed designs made following these guidelines. We checked the design at a series of checkpoints and achieved a set of plans, which went out for bid and were constructed with less than $8000 worth of construction changes, this indicates ~~indicating~~ that ifyou know what you want and you tell the contractor, he can build it and it will be what you want. As I mentioned before, ~~some of~~ our early contracts were ~~half~~ hampered by massive construction changes. ~~Our inability~~ we were unable to buy GFE such as cafeteria equipment and ~~handed~~ give it to the constructor in time, ~~and this was our inability~~ we were reasonable to foresee the lead time necessary to get this equipment. Our

inability to hire the designers to pick the equipment specified and our inability to get the manufacturers for the equipment to do it on schedule forced us to hand this task to the constructors, as a contract change. This is ~~not~~ hardly the ideal way to modify a construction contract. ~~Negotiate the change order. It resulted in problems so~~ the generation ~~negotiation~~ of the preliminary engineering report and anything else that would tend to improve the status of the drawing and to give us better control of the construction contract was the desirable thing. After we did Bldg 45, subsequently ~~in '64 prior to FY-64, and FY-65 and '66~~ these became requirements of our Hqs and ~~subseqnetly~~ Congress has decided these are so desirable that they have become a requirement on all Govt instllations. We were the forerunners ~~here~~ of a technique that has subsequently become standard. ~~Congress feels this is a must. In that regard,~~ our master plan was so highly thought of that by FY-65, every governmental installation was given the responsibility for master planning, ~~they~~ and are required to create a master plan ~~and the requirements~~ - Congress felt our master plan was so desirable, The requirements follow the pattern of our master plan ~~whether it was right or wrong since we were the leaders, we forced all other governmental installations into master planning~~. This is ~~not~~ a most desirable thing, but not ~~the~~ cheapest ~~thing in the world.~~ We were planning ahead for what our facilties might look like 10-20 years from now. What our utility requirements ought to be, what our future demands as the Center changes in concept might be, and this master plan is updated regularly so where the basic planning may not be changed, the refinements of each years' thinkin g are added ~~on~~ so you do wind up with a projection that is brought up to date, adjusted each year and ~~this ax~~ becomes a ~~it a~~ fairly accurate document. We can fairly predict what our needs will be 3-4 years in advance ~~because obviously we have the basis of a number of adjustments~~

of a pretty good posture so to speak. The preliminary engineering reports, the initial ones we did directly; subsequently the Corps selected the designers to do the preliminary engineering report, and in one incidence in FY-65, they selected arbitrarily designers other than those who had done the preliminary engineering report. To our minds this lost some efficiency in the translation, although obviously the report is a document that permits this. It should not be mandatory and a well qualified author of a preliminary engineering report could very effectively carry on and do the detail design thereafter. Because they arbitrarily or mandatorily selected somebody else, the next year we worked out a plan with them so they and we would be jointly involved in the selection of the engineers with the preliminary engineering report, and subsequently they and we would be involved in the selection of the engineers in the final report. With this joint participation in the preliminary engineering report selection, we got the continuity we needed and the joint panels selected firms who were capable of doing preliminary engineering and if they did a good job would go on and be selected to do the final design. We later began to go into the detail design of more moderate structures directly. In that connection we were always engaged in a direct contract administration effort at EAFB. Very early we made a survey of EAFB which was a World War II training center done with typical theater of operations, temporary construction, and our survey indicated there were about 100 buildings whose rate of deterioration was not so great and they might lend themselves to remodelling at a fairly reasonable cost. Remodelling or rehabilitation to the point they were habitable. We entered into a series of contracts to redesign these buildings and patch them up to the point they could be used; the better ones first and the poorer ones later until we finally ran out of those

we could afford to remodel and the AF ~~tended to~~ destroyed those we couldn't use. Considering we were spending from $4 to $8 sq/ft on these buildings to get them habitable, and were able to get a few years' wear out of them, ~~this gives you an idea~~ indicates that it was not an impractical solution to our housing problem. We have been able to get and keep people there for some time. This is not a desirable ~~area in which to consider~~ on permanent basis. ~~You~~ We will have to tear these timber buildings down and build others if ~~you ever want~~ we plan to stay at EAFB for a long time. ~~to survive here on the long swing.~~ The hangars on the other hand, ~~the~~ are more permanent buildings, and some of the masonry structures have a fairly long ~~sustained~~ life ~~and~~ the unit cost for maintaining them in an operating state if not ~~too~~ great. But the original 70 buildings, ~~you can't~~ we couldn't afford to spend too much on them ~~you must live with them~~ we had to use them in a semi-habitable state ~~and~~ they only serve as a temporary expedient. The amount of money we spent on these buildings is comparable to the rent we would have to pay for other space. It's the only way it could have been economically justified, and they their initial cost has been amortized at something about the rental rate. The buildings that we had to spend about $8 sq ft to fix, I think are the buildings we are still occupying. Those we spent a few dollars on, we got two years' wear out of them was well worth it because $2 sq ft in 2 years isn't an unreasonable rate for buildings around here and that's about what we had to do. They kept us out of the weather and they gave us a facility nearby. As you know, we are going to continue to occupy portions of these the better buildings, for as long as they are economically feasible and usable and those contiguous to the runways we are going to continue to occupy as long as we need them.

Unless we ~~were~~ are willing to move to another airfield there will always be a requirement for EAFB. The relative location of EAFB strip to our site has always been an interesting solution to our problem. We could rent space at the Houston airport, I suppose, but it would not be as economical or advantageous as using EAFB as long as it is a field that is close to us and operative. I doubt whether we would want to operate it ourselves, ~~although~~ because we just don't have enough need.

When we went into EAFB, we made a survey of the buildings that were available. Obivously the better buildings were in use, so we did get what might be called the least desirable buildings, but these were the only ones offered to us. We coul d move most or moving other agencies out, we could break the contract with the Coast Guard and get a good hangar, etc., but ~~we are~~ these are long term commitments that were made. The Coast Guard had a commitment, ~~they had building military unit assigned~~ and NASA has always felt they did not want to displace the other units that were there - merely to join them and use what space was available. To that end, I don't think we ~~could~~ should be too critical. Certainly it would have been desirable if no-one had been using the better hangars so that we could have had them. ~~and~~ It certainly is obvious that the maintenance on our buildings and our area, paving, utility systems, etc., since we are in the least permanenent portion of EAFB, that maintenance is greater per unit of transmissions, ~~line~~ miles of water main, etc. - so ~~I think if we don't share equally,~~ we are probably picking up our fair share because it does cost quite a little bit. ~~EA~~ We got some poor buildings and it is only by the grace of the Lord that they hadn't been burned down before. ~~It had been there much too long.~~ A ~~5-year like~~ buildings with a 5-year life ~~and they~~ were ~~an~~ most 15-20 years old by the time we got them. ~~They had gone past the period of senility, let us say.~~

I think ifyou want to stress anything now, we ought to talk about why did we get rid of the Corps, and to say it that way implies that it was a drastic that we kick them off the site contest and this isn't true. I think it ought to be fairly indicated that as the volume of building declined, the amount of activity we had, the- it was essential for us to minimize the cost of administering this. We could with our staff we had created to be in surveillance of the Corps' activity, we could redirect that staff and we could do much of the work we hired the Corps to do on a small program. We had the staff created for a big program. The-on We had to let our people grow and started diminishing and the Corps had to reduce its staff too, or we faced up to the fact we could within our own framework do the job ourselves. This is what we are doing right now. The Corps completed their activities with the conclusion of construction on Bldg 9 and we now administer the contracts and handle the construction contractors ourselves. We use a little different framework that rather than when we have a job of substantial to hire inspectors per se, we provide the overall surveillance and techincal inspection and we hire help from our des gners, Title II help, We hire the support help from our designing team and find this is an economical solution to our problem. We can achieve within the framework of our own organization, plus the hired help, the administration of a moderate size construction program and unless we would get into major size construction problem, we can handle our own construction effort effectively and well. If it's an exceptionally fast job like the LRL, one that requires a relatively short construction schedule, the form of the contract may be different than the Corps could possibly do. In that case, we have cost plus award fee concept and under our framework of contracts, procurement, etc., this is an easily accomplished form of contract. Yet the Corps of Engineers has not the ability to go to this abnormal

form and administer it in spite of the fact that it's obviously a desirable thing on a highly technical facility like the LRL.

Remote sites construction. During the period we were building here at MSC, we also had the problem of creating facilities at remote sites such as White Sands, we've had pastures created for landing strips nearby, and areas that were not in Houston. But these problems at White Sands we although we did have the Corps as partners, generally speaking, this remote sites construction was under our more direct supervision. The management of those activities went on in our contractor's plans which involved surveillance, a general analysis of their procurement techniques, the assurance that they were reasonably constructing facilities within the budget. Thus we had a secondary interest rather than a primary interest. We did not literally watch every brick go in, but we maintained them under surveillance. Similarly we had project engineers assigned to do White Sands, maintain the surveillance on that, The area office being generally responsible. We had a significant interest in activities at Kennedy that were related to manned space flight. What individual buildings cost. With respect to cost, it might be well to look at the terminology incremental funding. As an example - we had out of the original $60 million in FY-62 the budget; about the sum of some 20-21 million dollars assigned to SESL. Enumeration at that time of all of when our ultimate needs were enumerated indicated it was evident that we could easily spend some $80 million within this building. By changing the size and shape of the concept, and by changing some of these basic requirements, reducing. We reduced the budget estimated cost from $80 million to roughly $50 million and subsequently, the following year FY-62, portions of this $50 million ultimate requirement were budget as we needed them so the money, so that by the time we needed to run the final test, we had created the facility that cost about $44 million. The same condition prevailed in the Mission Control Center.

Fact of the matter, I think the MCC started with about $5.1 million of budgeted funding merely to get this basic design started and the concepts for the hard building foundation built. Then we add3d to that and including all costs, the turnkey costs of that building, probably was substantially over $8 million.