

Interview with Bill Sneed:
July 26, 1973

RB - If we could start by your giving me a summary of your background, education and how you came into the Saturn program and your relationship with the Saturn V program office or Saturn Systems Office, too. Were you involved in that?

BS - Yes, it was the Saturn Program Office.

RB - So why don't you go ahead and take a running start at it.

BS - I guess as I see it programs kind of come in three phases, the group who kind of does the basic work and gets the program off the ground and that's the initial contingent of people. And of course that was the Saturn Systems Office under Dr. Lange. He was, I guess, involved in the program up until about 1962 or 63 at which time the real emphasis started to develop on the Apollo program. The decrees were made that we were going forward with the Apollo program and pretty hard milestones were established. It was decided at that time that we would have to shift our emphasis and kind of get with it, so to speak. Apparently the center management took a look at the organizational structure, etc. that we had in existence at that time and did elect to form a new organization which significantly increased the emphasis on program management. Up until that time we had been principally let's say a dirty hands-type of operation, very heavily in-house oriented. We had developed the Jupiter in-house and had developed the S-IB stage for the Saturn I vehicle in-house and had done most of the engineering and conceptual-type work even on the entire launch vehicle.

RB - You manufactured the first eight S-I's.

BS - That's right, so that's the dirty hand/^{approach}I'm referring to. On the other hand on the S-IC we had undertaken to actually design, develop, manufacture I believe through the first two flight articles in-house with support from the Boeing Co. That was to have been transferred out-of-house effective with the 503 vehicle. In order to get that increased emphasis the center changed from more or less a laboratory-structurally-oriented organization to three basic organizations to get that balance that I was talking about. We had the program management organization and the systems engineering organization, which contained all the laboratories, and in essence your administration organization under Mr. Newby.

RB - This was about 1962?

BS - This was about 1962-63 time period. I can't recall exactly when that

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was. Bob young, I believe it was, was called in from Aerojet.

RB - What was the rationale for bringing in someone from outside. Did this kind of come from Headquarters?

BS - It's my understanding that there might have been a little pressure brought to bear to increase this emphasis and to make sure that we had a good balance of emphasis on the program management as well as the engineering. I've heard it said that Mr. Webb was a very strong advocate and had certain goals and objectives of being recognized as one of the best managers in the country and wanted NASA to be recognized as such. And I'm sure that this reflected some of his personal thinking.

RB - Part of it may have been the fact that he viewed Marshall as being kind of a dirty hand operation up to at least this point--say '63. And that by bringing in a sort of a top industrial manager from the outside it would help the IO group get started in better fashion.

BS - Yes, of course we were shifting, we were starting to let, in fact contracts at that time had been let to industry for the S-IV stage and I believe Chrysler might have been on board. I'm not sure. Boeing had been selected for the S-IC. At that time we had not selected the instrument unit contractor. But the program was growing at such a rate that we were really shifting more and more work out of house and less in house. The decision to do this I think was kind of looking ahead instead of any reflection on perhaps--certainly no non-performance on the part of the center. It was just a matter of saying we're going more out of house. It's going to take a little different type of organization to handle that. I believe, surely, that that was the main thrust of the reorganization.

RB - Young was not here for much more than a year, was he?

BS - Approximately a year or two years I can't be certain. And then O'Connor came in and he must have been here at least four years.

RB - Could you comment on the rationale for that?

BS - I think that in setting up the new organization they wanted a person who was familiar with the industrial side of things and I'm sure that they were

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going after a person who understood that and was trying to get within the industrial operations group the learning, the guidance and direction that would help steer that effort--trying to get a proper balance between a group who had been doing, and perhaps had a tendency to overtell the contractor how to do the job instead of what the job was. And I'm sure that they were just getting the best. The vice president of a company or an industry would be the logical candidate that you had. We had no industrial tycoon necessarily in-house so I think it was decided to try to get that kind of emphasis in. To me it was a rather profound decision because Dr. Lange had kind of headed that activity, but he was one of the in-house types, the dirty-hands type himself, very heavily scientific oriented, I understand.

BS - Art Rudolph, who I guess would be the closest thing that Marshall had to that kind of person. He had been in charge of the production phase of the V-2 project, and he had been quite experienced in that, plus he had been exposed to industry via his prior assignments on the Jupiter or Redstone program. And he was project manager for the Persian thing and he had had a lot of experience dealing with industry on those programs and certainly knew the in-house activity. I think he had the qualifications for it, but at the time he was on assignment to Manned Space Flight. He was in one of the systems engineering field offices located here at Huntsville. We worked for Joe Shay who was located in Washington at the time. Dr. Shay had two field offices, one here and one in Houston. We were located out at the head building during that period, something like 18 months to 2 years.

RB - It's not my intention to get into personalities with you, but the change from Young to O'Connor--it seems to me something should be said about it. Was O'Connor a likely prospect because he had the Air Force contracting experience? And, by the way, if you want to make an off-the-cuff comment--not for attribution, you can do that.

BS - I'm not sure that I had privy to all the thoughts that went into that. I can't recall specifically whether General Phillips had been selected during Bob Young's tenure or not. Of course General Phillips I'm sure was selected probably across all spectrums, whether it be industry, or the Air Force, a large systems-oriented program manager.

RB - I said O'Connor, I meant Phillips.

BS - General Phillips was in Washington. Bob Young was located here, so there was no interplay between that. The point I was trying to lead up to is that if Phillips had been selected during that period of tenure when Bob Young

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was here then Phillips could have been a very heavy influence in selection of the next man to come in. And perhaps having come from the Air Force systems command and knowing the kind of problems we were confronted with perhaps it could have been that influence that maybe shifted towards Air Force command versus, let's say, industry. I don't think I should comment beyond that. I have some views, some personal views from personal observation, but it's just based on my own assessment and I think it could be totally wrong. It could be totally misleading. I'd rather not even speculate on why that decision might have been made. I would be the first to say that I think it was a good decision. I think Gen. O'Connor brought with him a background in systems management. He brought with him, I think, almost a perfect personality which fit the scheme of things. He provided an excellent transition, I thought, or if you will, a means of communication between a group who for years and years had been doing it and had a tendency to want to tell a contractor how to do it and industry who, some of which, had never been subjected to any penetration. You know, you give me the contract, you give me the dollars--I'll see you five years from now with a product-attitude. And that was a hell of a span in there.

BS - O'Connor's personality, his makeup, was almost perfect for helping bridge that gap. He was an easy-going person, very persistent in a very quiet way, very patient in understanding and resolving this transition. I think that the decision to do that was very significant. Now Bob Young was a little bit more dynamic. He spent quite a bit of time on the West Coast, perhaps as much out there as back here. And I think from where he could bring his own influence to bear, obviously he did an outstanding job. But the job at hand was one of kind of bringing all the troops along to understand that transition and to get everyone working in the environment and with the ground rules in the direction that he was trying to steer us. He was doing a little bit more himself than was getting done through the efforts of others--this job, and I don't think this was necessarily a reflection but it was a very apparent difference between the two personalities that we're discussing. I think for the situation at hand Gen. Phillips just seemed to be the happy medium. It was a very effective arrangement. I said Phillips, Gen. O'Connor.

BS - Of course that made it extremely easy for Gen. Phillips because, either Phillips was on before or after, they spanned about the same period of time as I recall. They talked the same language. They were indoctrinated in obviously the same school of learning and experience. That certainly provided us with an excellent rapport with the Apollo program office in Washington under Gen. Phillips.

BS - One can speculate on several other aspects of the thing. I would just mention them, but certainly not comment on them. I don't know whether there were difficulties with the previous Apollo program director which is in Washington,

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I don't know whether there was any problem with "that fellow" Gen. Phillips wanting to get a responsive-type person here to him, which the two-star general and the one-star general arrangement kind of automatically took care of. I don't know whether there were any problems with that or not. It was not apparent to me, but it could have been a factor in the decision.

RB - Did they operate in those relationships or at least in the NASA organization and the MSFC organization--did they operate basically a civilian-type management? Were they just kind of on-leave or on-loan from the Air Force?

BS - I don't know what you would call it, but both were wearing civilian clothes. They were working our hours. I guess you would just say on-loan to NASA from the Air Force. Just on special occasions did they have to wear their uniforms. To me it was an excellent relationship--they were the very best.

RB - Getting back to the old Saturn systems office and I realize there was another thing in there when the Saturn V came in really under the SSO, but basically the difference between the SSO and the Saturn V program office was the SSO still maintained a stronger kind of dirty-hand thing ~~in~~ ^{and} the Saturn V program office ~~had~~ a much more managerial flavor to it.

BS - No, I would say that there was probably more difference than that. The SSO, Dr. ^{Lange} had the unenviable task of trying to impose program management over an engineering organization. He was not overly supported from all I could gather. Overly supported is not the right word. Dr. von Braun and Dr. Rees were developing ^{ingent} engineering-oriented people. Their thought pattern was more to get the job done right, no failures and that sort of thing. Well, that's not exactly conducive to getting the job done on time within dollars with certain constraints. Dr. Lange, with the major emphasis on a doing organization, the line organization was all engineering. It was laboratories. It goes without saying that under such a setup your line organization is going to prevail. And it was a very painful process to impose on that structure a discipline or forcing function which made things happen in a certain manner, or which was an orifice between those people who felt deeply responsible for the job even though it was contracted, almost shared in responsibility. In fact there was even more motivation and sense of responsibility here than there was perhaps on the contractor. And then to try to insert yourself between that type of person and the contractor who might just be hiring people in quantities, not necessarily motivated at that point of time. Then obviously if a guy wanted to tell him to do something and the Program Manager was sitting there and says wait a minute I've got a contract. I've got to have money if I'm going to tell him to do that. Your telling him to do that is a thing that would delay my schedule by a period of time was, as you might well imagine, a very sensitive issue.

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And obviously I think had something to do with the decisions to re-orient perhaps the emphasis we had so that you get a little better balance between the management and engineering.

RB - That was the reason why Rudolph emphasized that his staff people had the same managerial muscle as the project managers.

BS - I'll get to that aspect of it in a minute, I'm not down to that level. Back to the Lönge-Bob Young, industrial operations versus the Saturn systems office. There were few people in Lönge--Lönge did not have a large office, he might have had a hundred to two hundred people to try to manage all of the activities at that time, it was relatively small. And, in my judgment, I don't think were of the experience or quality levels which were required to manage billion dollar programs. With this change the Saturn systems office went from something like a hundred to two hundred organization to a thousand over a period of time. Good quantity and, in my judgment, more quality, more experience into the management of those programs like bringing Dr. Rudolph back to manage the Saturn VC. He had managed very, very successfully two major programs of the Thor and as was indicated was probably among the most experienced and most qualified of anyone at Marshall to manage a major effort. I think maybe he was unchallenged in that capacity.

RB - I can't remember the other managers. Did they come from within Marshall or were they brought in from other areas?

BS - We had, I guess, three major blocks under that industrial operations group--there was the Saturn program which was headed by Dr. Rudolph. I was trying to remember whether Bob Lindstrom still had IB at that time. I believe Lee came in subsequent to this. Bob Lindstrom had the other office for awhile and Bob left to go to industry and Lee James came in to assume responsibility for the Saturn IB. And then we had the engine program office under Bill Brown. Now all of the program managers were selected internally. Lindstrom kind of came up through the ranks, I think he got his first exposure here through the military if I'm not mistaken and was just an outstanding manager in my judgment. He is now deputy manager of the shuttle program. Lee James was principally military. I think he had retired from the military and I believe was on assignment with Dr. Rees in some kind of special capacity and when Lindstrom left came down to assume responsibility for the Saturn IB.

BS - I might add a very significant decision made by Dr. von Braun and I guess a very painful decision. In establishing these program offices he truly named them #1. They were the final decision on all matters relative to the

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program, technical and programmatic. That is a ^{charter} ~~change~~ which Dr. Lange never enjoyed. Under Dr. Langer the technical decisions prevailed. With the establishment of this new setup, and again I think it was commensurate with the times. It was about this same time we made our selection of the mode in which we were going to the moon--the LOR mode as opposed to the EOR. And the time was set and dollars started to jell. Things had to happen on time. Before that, we were in kind of an open-ended environment. In other words, no hard commitments to make. Under those conditions you should do it as he was doing it. von Braun was one of the most brilliant managers and engineers and systems engineers that I have ever, ever come in contact with. I think that he realized that he had to shift and get this balance in his structure.

BS - So he issued, and I believe it was called Management Instructions #1. I did for awhile still have a copy of it because it was one of those things that you hang on the wall. It was a major decision to say that the program manager will have the final say on all matters pertaining to his program. Up until that time it was not that way at all. The program managers were almost implementers instead of managers. So I have to register the decision to get that balance and the decision to give them the authority and responsibilities commensurate with those assignments--I have to put those right up in the key decision category.

RB - You said it was painful--von Braun had a natural reluctance to let things kind of go to other people.

BS - He was innovative and certainly our labs were innovative. And I think it was a situation of putting an orifice into that innovation and saying "no" to it occasionally or frequently. Saying "no" to it--that is a pretty painful thing. "No" to the labs. Up until that time if they wanted to make it round or square they said make it round or make it square and the program manager says contractor make it square. That's what the lab said. And I'll go out and see if I can find the dollars to do it. In this case the labs would say make it round or make it square and it would come to Dr. Rudolph and he would say let me see the impact of making it round or making it square. And if he said making it round instead of making it square would cause me to delay a program six months or it required 10 million dollars which I don't have, and I don't consider the risk of not making it that way to be significant then my decision is to leave it as it is.

BS - So that's the traumatic change in mode of operation. And it is in that connection that I say it's a little bit painful. von Braun's major organization was innovative-oriented and here he had had to impose in order to accomplish the objectives of the Apollo program, he had to impose this control

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over these people and obviously that was a painful process.

RB - So that was the import of the national overall program and requirements for scheduling and costing and funding...

BS - ~~B~~That's right. You really started doing program management and system-management instead of with the emphasis totally on the technical aspects. Now this put a lot of pressure on the program managers to say the least because you don't change that attitude or that mode of operation overnight. And we had to do an awful lot of deliberation on all of our significant decisions. And of course von Braun being astute left the channel open that should a lab director, let us say, take violent exception to a decision that was rendered by a program manager he had an appeal--authority back to von Braun and von Braun would hear the case. We used that a time or two and fortunately for us on one or two of the real early decisions we had to make we had done our homework well and we won our case. Then the tendency to want to do that dropped off, but it was always open. And of course we were sensitive to that and we knew that when we were making a decision over the lab director that we were assuming the responsibility for the thing working in the context. So you don't take those things lightly. We went out of the way to try to really assess and understand the significance of the change and to do the ground work and by persuasion and logic indicate to the person proposing it, why we were doing it. And of course that minimized those objections to our decisions.

BS - But there were other mechanisms they had for letting ^{their} ~~our~~ complaints get known through the weekly notes to von Braun and we were constantly getting little annotated notes over from this lab or that, Well, why did you do that or Walter has complained about that decision, would you give me the facts and details--Haueserman or others and it came hard for them. But again I think the fact that it did was a healthy situation. I'm not in any way saying this is bad because I'm telling you it gave us a--it put the pressure on us to really think a thing through. Now a contractor, they are under contract and if they overrun, that's a bad thing, and your dollars and schedule were slanted a little bit in favor of the--just the programmatics side of it more so than the technical. Now that is not to say that they would take undue risk. They were responsible people. But I think the dollar motive, the desire not to have an overrun in the contract and to get a good return on the value of the contract was a little bit stronger there than it was here. I think we were more tended that we wanted a successful job within the dollars. And these two really complemented each other. And it was painful, but once you got through the process I think you had that right balance. It was a very healthy situation.

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BS - So I think that was one of the major differences between the two offices-- the difference in authority level that they had. And as I said I think we had 250-300 people on the Saturn program office under Dr. Rudolph. I was in the Program Control Office of the Saturn V. I guess we had more people in that program office than Dr. Longe had for all of his activities before. And we were

by far the largest group underneath the industrial operations group. I had been with Dr. Rudolph through Pershing and was with him at the Hickville in the systems engineering assignment with Dr. Shay. When this change was made-- we were originally with the von Braun team--even in the Army before NASA was formed, we had the Pershing program office at that time. Because we were at the height of the development of that program it was decided by von Braun and Gen. Medaris that that group would remain behind and would not make the transfer with the rest of NASA. So we stayed with the Army for an additional two year I guess. And then Dr. von Braun, again with his vision, once we finished that assignment we wanted to come back to NASA. And I think rather than bring us in to Marshall and maybe be lost in the hierarchy here it was his decision, again I'm sure in agreement with the Manned Space Flight Director, Brainerd Holmes I guess it was, that we would work with Joe Shay in a systems engineering capacity to try to integrate the elements of this center with other activities at Houston and Kennedy, which was breaking off at about that time. I think that management policy shift was a key to that.

BS - While we were at the Hick Building was when the decision was made to form this new organization IO. We started to think about how do we go about doing the job, and while we were still out there we came up with the concept that we thought would work, and it was kind of a matrix, a management concept, where we utilized staff offices in addition to hardware management offices. I'm sure you are familiar with all that. I guess we hadn't much more than completed our own homework on that and started to identify people and negotiate the leaders for each of those boxes and estimate the number of people required for staffing its skills, etc. than Dr. Mueller came on board in Headquarters. He had some of his own ideas about how things ought to be done and he shifted the Headquarters organization around quite a bit. They were a product-oriented group up until that time--launch vehicles and spacecraft and engines. That meant we were all kind of thinking in the same pattern and he elected to go functional rather than product.

BS - He went with offices of systems engineering, program control, test and all the groups, but functionally oriented instead of staff. Well, that made a beautiful arrangement because that meant that they were cutting down the entire stack. They were systems oriented as opposed to being Saturn. Because that's the way the centers were set up. So again that gave us a matrix approach and gave us a person who was up there who was looking at program control. Program control was getting the job done on time and within dollars. That, of course, was for everything, and a fellow could keep a balance. If one element got out of balance you could kick him back into balance by shifting of dollars from here to there.

RB - Did these GEM boxes kind of evolve at the Marshall level at the same time as they did at Headquarters? Did Mueller say we will have these GEM boxes and Marshall will have them too or how did that...

BS - We had..we were ahead of Mueller by some period time, and I don't recall how long. And it was fortunate, I guess, for us that our thoughts were almost identical with Mueller so that when he came with his Mueller boxes it was totally..

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RB - He didn't necessarily look at the Marshall organization and say, hey, that's a neat idea.

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BS - It was not in existence/that time. We were still in the proposal stage to Dr. von Braun. We were still at the Hickville then negotiating our transfer here. And it was within a matter of weeks or months that I guess Mueller's concept emerged. We had this, program control and system engineering and integration test and R & QA were our five boxes. And then we had underneath there S-IC, etc. Now, Mueller's boxes addressed only those so we had a natural build-in to where I could interface directly with the program control chief in Washington who was an Air Force Colonel, Sekkam. And I guess Phillips had to be on board--didn't trigger something I didn't recall. But Sekkam would not have been there had Phillips not been, I don't think.

BS - Logic kind of tells you how to do that. It was not all that innovative really, but it was profound, I think, that we did it. We had a stack to worry about. We had five boxes down here. You couldn't have every guy just running off on his own. And we had done some work on our systems engineering activity that indicated like in your R & QA area. You had to worry about reliability and quality for your entire stack and not just one piece of it. So it was a systems oriented group.

BS - So this was implemented, not only for our program but for the other, this part of it was incorporated for the Saturn IB and the engine program. We stayed with that throughout the entire development phase of the program. Within program control I had principally three major functions, schedules for the entire system, responsible for the Saturn budget which I think peaked out at something over a billion dollars, and I had the configuration management responsibility because--This came on kind of late in the game and was one of the real advantages, one of the good things that I think Gen. Phillips brought with him from the Air Force, some of his management system concepts. Configuration management was one he exposed us to.

RB - Could you talk a little bit about configuration management--what it involved and what you were getting at?

BS - Configuration management, in my judgment, is probably the glue that puts all the pieces together. It starts with your specifications or your requirements for doing the job. For the Saturn, we had a Saturn program spec which says the Saturn shall do a certain job. In other words, place the spacecraft at a certain point at a certain position and all those good things. And indicated what its payload carrying capability would be and all your system-level type requirements. And it identified then what the interface would be between that vehicle and the space craft and between that vehicle and the launch operations. Now we took that and developed specifications for each of these elements down here, the hardware. So we had an S-IC project spec, an S-II project spec, and we had the ICD identified that put those two things

together, interface control document. When we started, this is something we inherited from the program office, the Saturn Systems Office I guess it was called, Dr. Longe's office. We just had a statement of work written that says you will do a job. The job was not well defined and the ICDs were a thing that was not even under the control of the program office. They were in the laboratory structure, the electrical guy and the mechanical guy. And the specifications I just don't know how well they were written. There was an Apollo spec that was developed by Bellcom for Gen. Phillips and then we developed the Saturn spec. to satisfy, that plus setting the stage for these things down below and then developed the ICDs. Now having done that, and this was a very painful thing. And of course that was the advantage of having dollars under my control. I could implement this. This was probably a 50 million dollar decision to implement the configuration management.

BS - But by having the dollars and allocating the dollars from my reserve to do that we were able to get it into affect. We removed the basic contract and the technical requirements, etc. and all the amendments thereto and replaced it with a specification and verbage there the contractor shall do all things necessary to satisfy the requirements set forth in the specification. So that gave him total mission responsibility other than again having our people to go out and tell them how to do it one piece at a time. So we got more mission oriented, a rather major thing on our part and very expensive I might add, But it was, in my judgment, well worth it. Then when we had the specification we knew what the job was, it was well defined in the spec. And then when people would come in with changes you would ask is it a change to the spec or not, is it required to make the spec work, if it is it's in scope and the contractor would be expected to do that. So it really put integrity into your technical management system. We knew what we were controlling. We were controlling to a spec initially.

BS - After we delivered the first two vehicles we said we are going to shift our emphasis of control from spec control to drawing control. Because after we had completed all of our qualification program and our test program and had satisfied ourselves that the vehicle we had delivered would meet the requirements of the specification we did not want the contractor or our lab people changing the system. We wanted to live with it. We had a job to do, we had proven it would work. Let's not make it better. Let's get our job done. Keep it the same. When we shifted the drawing control then of course there was a perfect time between the spec. We shifted the drawing control strictly for technical control purposes, not for scope control purposes. We left the spec on for scope control purposes. I don't know whether that makes sense to you, but the contractor was still required to deliver a vehicle that would satisfy the specification, not satisfy the drawing because we had not flown at the time.

BS - So we have continued to have to make changes to the drawings, the top drawings during this period of time, but if they were made to satisfy the spec then they were in scope. It was considered negotiated and the contractor was expected to do it without change orders. Fortunately for us, we were converting our contracts from CPFF to CPIF--cost plus incentive. At about that same time, fortunately we were having to open all of our contracts for renegotiation

and it was a very opportune time for me to implement this system. In other words, when we went to an incentive that forced you to get more mission oriented and having the spec was automatic, it just fell right into line, our timing was just perfect and we were able to slip that in. Otherwise I don't think we would ever have gotten it in. We would have had to do it one contract at a time. It would have been a very difficult chore, but this way we had the forcing function working for us and we were able to get it in.

BS - Now in connection with that, consistent with the specification tree, then we set up control boards. And we had a configuration control board chaired by the Saturn program manager and he knew what had been baselined and what our requirements were and he had something to control from. Prior to that we didn't have anything to control from. That's why I say it really added integrity into it.

RB - So if somebody wanted to change something you really didn't know how..

BS - You didn't know what you were changing from really. You were just telling him to do something and you didn't know whether he was already doing it, should have been doing it or not. And this provided us with a mechanism of knowing that. The cost fell right into line then. Then you get technical control. Until you get technical control you don't have cost control or schedule control. So that's the technical control of the program and I did that under the banner of Configuration Management. I'd be happy to discuss that with you in any further depth.

RB - Configuration Management then, I don't want to over simplify, but was kind of the paperwork aspect of it in a sense.

BS - I hate to use the word paperwork. Too often it's referred to as that. I think I'd like to say it's the configuration management system. You manage a program with paper as you well know. Technically you manage a program with requirements, specifications and drawings.

RB - But what I was trying to get at was something of the difference between Configuration Management and Systems Engineering. And the Systems Engineering was involved really with the mechanisms. Is that right or how would you differentiate?

BS - Well the systems engineer is the one who would write the specification. Your configuration management in the sense that I had it here was the emphasis on systems. What is configuration management? What do you have to have to make it work? Do you use drawings, or do you use interface control documents? Or do you use customer interconnect drawings which we had at that time between the stages and the engine? Or just what do you use? How do you express requirements? We determined, and again starting with the Air Force Configuration Management System 375- , I think. We started with that and of course we weren't recreating the wheel. We adapted it to our use and came out with 500-1 or something which was a NASA document. We decided that we would have some

specifications that would be our main mechanism for operations. So our systems engineering people, under this box here, working with the laboratories developed the Saturn V specification, launch vehicle specification. Now that specification is where you do your systems analysis, that's where you say this stage will be this large and have this much capacity, it will carry you up to here, you separate and all that good stuff which was written into the spec. But the spec would be laid on the table, so to speak, by the systems engineer then. And then what do I do with it? Well then my job was to get that on contract as a control document. And then your integration function was a person worrying about does this fit this and does the overall Saturn vehicle fit the spacecraft, and does this fit into launch operation, and does all that equal the vehicle system.

BS - That's how your ICDs were evolved. We placed those on contract. Now that was a painful process to say the least because this contractor was working to what he thought the interface was, and this was working to what it was, and the guy over in the lab in his desk might have had a drawing that reflected what that was. So we had to almost physically take those drawings. It was a very traumatic experience for those people to give up control of those drawings. We took those and actually physically placed them under lock and key in the depository. We gave a copy of the ICD to that fellow and to that fellow and said, does your hardware as you're looking at it today look like that. And where it does not you come back into me with an identification of each and every item. We asked this fellow to do the same thing. And then through negotiation with those three we finally got a document that was acceptable to all three of us.

BS - And when we did we said o.k. that's base line now. Henceforth and forever more you'll never change that. You do not have the prerogative of changing it. That will be a level to a change which comes to our Saturn level 2 change control board. And anytime you have a change within S-IC that affects that interface it shall be your responsibility, as an initiator of that change, to get with the people affected by it, discuss it with them before the fact before you make your submission to the extent that you think it is feasible, and then submit to me an ECP that would take all those things into account at one time and those other fellows will come in simultaneously with that. So that when I made a change I was making a change knowing what the impact was across the total system. Now before that time, this fellow would make a change, hell, it would already be implemented. Like Matt Erlock on the S-IC, and then a month later, a year later, you've got to change the S-II because they don't fit. And it might have cost Matt \$2 to make the change on the S-IC but it might have cost a million dollars to make it on the S-II.

RB - You mentioned the ECP?

BS - Engineering Change Proposal. So, as it was we might get five ECPs

in simultaneously for one change so we wouldn't let one fellow make it until we had assessed the impact across the board. And then when we made that decision we turned em all five on at one time. So that's why I say it's really the backbone of technical control. It's the key system of all--configuration.

BS - And in the budget control I used in essence the work package system for controlling that. I had that and then the schedule. You've probably seen the Saturn V control center that was established to handle that over there. I had the schedule control. You shall do the job here and make your deliveries here. The test program shall be completed in accordance with these milestones. I had the budget set up and I had the specification and ICD control so I had all three things under control. I hate to say I--working for that fellow I wouldn't have had anything if he hadn't supported this concept of operations so much. And I would say to you that Art Rudolph was responsible for making this work right here, totally and solely responsible for making it work. He gave equal responsibilities and authorities to these two people--this level of management here and here.

BS - He said, look, I see it this way. I see program control, systems engineering, test and quality, etc. coming down this way. I see going across S-IC, S-II and S-IVB. That's what I mean when I say matrix management, perhaps that's a familiar term to you. So that fellow had to look this way and this look this way and he gave both views the same emphasis. He is the only one who did that.

RB - That's unique with his office?

BS - Within Marshall it was. The organization was not unique. We had it across the board. But Lee James operated a little bit more strongly down here. Now Lee was an unusual fellow. He had a tremendous capacity and was able to do a lot of this integrating of these things down here himself. Of course he had a smaller job than we did too so it was a little easier for him to operate that way. Art really did that. For example, the configuration management system was totally conceived and implemented by my organization working with the authority of Dr. Rudolph.

RB - This is one of the things I wanted to get at. What made the Saturn V program office so different? And this is one of the things that Rudolph gave as much as possible equal responsibility to the staff.

BS - That's right. All the innovative systems that were developed were developed within the Saturn V program office. I would say we had somewhere between 35 - 40% of our total personnel in this capacity. And I'd say about

60 @ 65% down here. I'd say about a third up here and probably two-thirds down here in the hardware. So that indicated we had that balance. That was how we managed to get technical control, and of course the schedule control I think is fairly straightforward and the budget control.

RB - You had control of the Program Control Center in your office? There was an interview with Rudolph some years ago. Akens in the Historical Office did it and Dave Christensen, you probably know him. And Rudolph said that he had trouble getting the Control Center established. Do you remember anything about that or why he would have had difficulty getting it organized?

BS - I don't know what he could specifically be referring to, but we did have trouble getting it established. First of all, some of it was just logistics problems of getting the thing approved. We like never to have gotten the concept approved by Gen. O'Connor, to be real frank with you.

RB - He didn't think it would work?

BS - I don't know why, but I guess that was the case. I just can't answer that. But we had difficulty getting it in any event. And of course there was the problem of finding the room for it. Space was a premium here at that time. That meant we had to use one of our conference rooms. We went first class on it as you well know. It was the hub of our management setup.

RB - As time we on it became the peak of all kinds of stuff.

BS - Yes, we spent about \$65,000 to get the room set up and we put nice walls and carpeting, etc. When someone walked in there we wanted them to know they were in a first-class place. We wanted to establish ourselves as the leadership of the program. We wanted the initiative. And we thought by going first class and being a little bit ahead of the rest of the center, and certainly the rest of NASA that we would be recognized as the leaders in the field. I think we achieved that as a result. I think there was an underlying thing here. Then the other resistance came from our project people.

BS - The center provided, of course, a mechanism of getting visibility and control again. And we put our data in there. I don't know whether you have had a chance to see all of it, but we put our key schedules, we had our budget data there. And we had some of our key technical data, like status, our weights and performance, our qualification status, and quite a few bits of technical data in there. Once we got that in meant we were taking things out of the hands of the project manager. Say we had a vehicle dynamics test that required hardware from two or three of these offices and we established control milestones

and said you do not have the authority, Mr. Stage Manager, to change that milestone. That will be controlled at Level 2 or at the Rudolph level. And, of course, they resisted that. They resisted having to put something before him that they could not change without discussing with him before he changed it. Once we baselined their schedule and put it in the room they could not change it until they had reviewed it with him and explained all the ramifications of the change. And when he said o.k. then we went from a little diamond concept to an arrow, and it became the plan again. Well, that was very painful for them because they like the labs did not want control. They were in control of their own destiny up until that time. So we had difficulties from them.

BS - And then there was the underlying problem of visibility and control. There are some things that I wouldn't talk about, but within certain people at the center they didn't want this. They just simply did not want this imposed on them.

RB - As long as there was a control chart up there, and as I recall one of the important aspects of it was the name of the guy was on the chart. And it really exposed him in that sense to successes just as much as it exposed him to failures. So, as you said, it could be a very painful thing.

BS - After we got the room up and established and it was in operation we started having our program reviews there once a month. They were two-day reviews. On the first day we would have the staff people present their respective areas. For example, I would get up and indicate how we were doing budget wise and configuration-management-wise, etc. The next day the project people would get up and present their respective areas. And of course we were able to identify where the trouble spots were. I had responsibility for the agenda and by having this I could get the problems of the guy up that was in trouble. And we were concentrating on problems rather than status.

RB - How did you know he was in trouble?

End of Side 2

BS - From his status-ing of his chart in the room. I knew what had to be done and when timewise. So we were able in this group up here to indicate how we were doing from a total program point of view because we were looking for the weak link in the chain at all times. Time was so precious you had to spend your time on problem areas and stay away from guys having the good story to tell you. And you had to force him to tell you the story he didn't want to talk about because he always liked to solve his problems or have a solution to them before he ever came to you.

RB - So you depended on finally convincing the project manager that it was worth his while to expose his weaknesses.

BS - It wasn't so much a matter of convincing him, if you're talking about getting the room set up.

RB - Well, getting his data on the board. If there was something that would make him look bad he still had to feel it was worth his while to expose himself by putting it up there.

BS - That was a judgment that he had to make. But every month when we had the program reviews I would indicate what the schedule status was. We had a status as of a day before that meeting. If we were at a point where a schedule was to have been met and it wasn't met then he had to declare it. It was a known fact. He had to indicate on there the technique that we devised and when it would be met and what the impact of that delay would have on any subsequent or related milestones.

RB - So it was worth his while to explain these problems beforehand in order to get full support from whomever to make sure money or time or expertise from R&D was...

BS - That's right. It worked to his advantage. It's hard to get a person to think of problems broadly, but by exposing the problem, discussing it, and making the program manager aware of it and let him know that he is working it then he's kind of executed one of his most critical functions. You know, keep the boss informed so he's not holding his breath. He knows he's got a problem, the boss knows he's working it. So he's doing all he can do to get out from under the work load, out from under the problem.

BS - On the other hand, if he sits there and holds his breath and not declares it and comes up and says, Art, I've got a six-months schedule slip. I've tried to solve this program, I didn't want to tell you about it. And this is going to impact 501 launch by six months then the guy would be subject to me of being fired if that's irresponsibility. Now I'm not sure that they really understood that rather basic management philosophy. You could get to the boss too early with your problems. That was, of course, the other end of the spectrum. But getting that balance in there between what should be exposed and what should not is the thing that we worked. Normally as I started exposing any schedule problems we would have I would try to make a judgment. Is it a nit picking thing? If it is I'm not going to make an issue of it. It's there, we're working it and I think it's under control. And it does not impact anything.

BS - Or, it's a real problem. Therefore, Matt Erloff you will be on the agenda tomorrow to talk this particular problem. He did not rely on me to do that. He exercised judgment. It was a thing that we mutually agreed to on so many cases. But I had the mechanism set up by virtue of controlling the

agenda to see to it that it got on the agenda, because Rudolph approved the agenda.

RB - You must have been reading the ^{PERT} pertinent information..

BS - Oh, yes, I knew who was on the critical path. And it's amazing how much discipline this put in our system. For example, if our PERT showed that the man was on the critical path there would be so many times that I knew that he was not. But I'd go forth with it anyway, it's a calculated risk. The guy would say. The PERT's no good. And I'd say, its your PERT I'm basing it on so get in and clean it up. So that's how I forced him to keep integrity in his PERT system. If he was lagging in that and it was causing him to be on the critical path and he came back and blamed it on that I'd say it's your data I'm using. Go in and clean up your data and you won't be on there the next time, I realize that.

RB - What about the contractors? I've heard that occasionally one of the contractors, especially North American back in the S-II problem days, would start finessing their own PERT cards that would come up. They would have midnight management sessions. Do you recall that happening?

BS - I guess I couldn't. I don't have personal knowledge of it happening although there is a tendency on the part of everyone to manipulate the data, to not be on the critical path. That's not the best place to be. You can't preclude that totally. You can do so much to make it work. They were in trouble and they were holding their breath thinking there would be something that would happen. Of course they had the biggest job to do. I want to say that in defense of North American. When I came into the program and really started making an evaluation let's say for any one given year, this fellow might have had a hundred million dollars to spend and he was a hell of a lot further along in the solutions to his problems than this fellow--he had twenty million. And it was about that bad a distribution. So, one of the first acts that Dr. Rudolph and I did was to put the money where the problems were. We made a major redistribution of that in order to help bail the S-II out.

RB - That's one of the things that I wanted to ask you about. The S-II became the pacing item and that some place I read the statement that Rudolph made that he just took money out of the pot and stuck it right back into S-II to crank it up.

BS - We did. One year, I think at the height of our problem, we increased

the North American budget, if I'm not terribly mistaken, from somewhere around 195-200 million dollars for that year up to maybe 280-300 million in an effort to try to buy back some of the lost time. Because our program was riding on their getting back on track.

RB - Where did that money go? Did it go into overtime? Additional help?

BS - Overtime, additional help, more people, backup solutions to problems. Like an insulation problem, we instituted a backup development for that in the event our prime system did not work.

RB - Was it another external approach that you had a backup for?

BS - External, foam spray. I would say it was probably more in people than any one thing. And then the Apollo program back then was in a little trouble. The performance curve of the launch vehicles was trying to cross the weight of the spacecraft which would indicate you wouldn't get there. We had a trend that indicated we had to do something in that control room. We had a plot of your launch vehicle performance which, fortunately for Marshall, because of our experience, tended to hold fairly constant. And normally a performance curve will come down because the launch vehicle gets heavier, etc. But we had reserves built in such that we could actually hold and even better that a little bit. We plotted the spacecraft weight and this thing started approaching that to a point of being dangerous. We had to make a decision. Do you redesign the spacecraft? They were already in a weight reduction program themselves shaving like crazy. In fact I think in retrospect it was one of the big mistakes we made in the program--not building a bigger reserve between the two.

BS - Or increase in thrust of the engine or going into a weight reduction on the stages. Again, in retrospect, without doing a total systems' analysis job I think we made some decisions on the S-II that were bad decisions. We were already in trouble on the S-II and, of course, if you get a pound out of the S-II or two pounds out of the S-II you contribute one additional pound to performance--two to one, whereas in the S-IC it was thirteen to one. And S-IVB was one to one. It was already a fairly lightweight stage.

RB - The difference there is the orbital or the trajectory consideration

BS - Right. We made some decisions on the S-II that went a weight reduction program to pick up five or six thousand pounds in performance that really got us down to almost the theoretical limits on the stage. And that just

doubled our troubles. So, in retrospect, I don't believe we would have repeated that. We took some weight out of the S-IC, but you had to take an awful lot of weight, 13 lbs. to gain one, and that meant you had to get into an awful lot of areas to make any money at all. The S-II was an area where we had probably the best possibilities of doing something two to one strictly from an engineering point of view.

BS - And, of course, the S-IVB was also productive because pound for pound you gain there. And we picked up some pounds there also. But the S-IVB was in pretty darned good shape. They were not on the critical path. The S-II was on the critical path and we were making these decisions of going in and shave down more and that meant that anytime that stage burped you had to stop and fix it. If you had a weld defect it had to be fixed. And therefore we got into serious trouble schedule-wise. We had to pour money in to get back on schedule. It was a very expensive decision.

RB - Was this poundage problem part of S-II's problem. You started taking weight off there and that also contributed to the S-II's problems.

BS - It would have been on the critical path had we not touched it. Then when we did this it kind of compounded an already impossible problem.

RB - What I meant was earlier when I talked about the S-IVB, I was thinking that it was already fairly well formed up so it would be very difficult to take poundage off that. It was already further down the line.

BS - No, not really. We were at the same time relatively speaking. We made this effective with vehicle 506 or 507. It had different effectivities so it wasn't a matter of taking something that had already been built and have the change. You had to do it in-line, it was in-line modification you had to make.

RB - In other words, you finally resolved the poundage problem two ways, by, you did save it in the S-II and they also through their weight reduction program got it down at Houston.

BS - Yes, the spacecraft was already on a super-duper weight reduction. Through the efforts of the two we were able to get this thing stabilized.

RB - That's really intriguing to me looking at it from a historical viewpoint--that fifth engine, the F-1 engine really stands out. Because that

initial configuration was only calling for four. And sticking that fifth engine there was a fantastically..

BS - That's what I'm saying. Marshall's conservatism was it. And we ^{had} ~~to~~ all kinds of ~~find~~ reserves that we tapped that was built into the vehicle. In other words, we had already built a tank that would accommodate that fifth engine. And perhaps in figuring the performance of the vehicle figured that you have maximum flight wind--you'd be flying right into the wind or something like that. So those were the kind of flight reserves you built in that you can call on when you get in trouble like this. A person needs about a 20% reserve in weight. I think instructors loan you about 17%. We had built in a lot, but obviously had not built in quite enough. Now had we done so the Apollo program would have been so much easier for all of us. In fact we reached a point one time when we wondered whether or not the spacecraft recovery system would be totally redesigned.

BS - We were limited in how much we could let the spacecraft grow because it was a tremendously complicated thing bringing it back. I can't even begin to explain it to you. All of those things were so closely related to weight. I think we went from something like 85,000 on up to 96,000. It was a job. But we had enough visibility to know where the changes should and could be made. I'm just saying that I think, in retrospect, made some judgments in the S-II that we would not have made if we could make them over again.

RB - Offhand, can you recall any specific thing.

BS - Yes, in the structure. We went from a safety factor of maybe 1.3 to about 1.2. But when we did that you brought that skin thickness down so thin. And then since 1.2 is cutting it a little close if you had any kind of a defect that would tend to bring it down below 1.2 or have us concerned. And it had to be perfect

RB - I remember reading about ^{when} the S-IIT blew down at MTF. They got in there and found that there were interior cracks. And so they started reworking some of the other things. But they had to grind them out so much. They actually had to put stiffeners on the outside of the skin and re-cover with insulation because the walls were so thin.

BS - The fact that we did this introduced this proof-pressure test program, something that was more cost to the program. So a very expensive decision was made there. But from a program point of view it probably was a good way to go. It was certainly better than going up into the spacecraft. But I think if we had it to do over again we would have looked a little harder at the engines to see if we couldn't get a little bit more out of them. *at the SIC and*

RB - Even at a thirteen to one ratio that's a gargantuan thing to work with.

BS - That's right, 280,000 lbs. is a very heavy monster. So you had your technical reserves. The other thing that I would mention to you that I thought was very profound that we had in the budgeting area--I was called as an allowance for program adjustment. That was really a funding reserve that I had. And in that reserve at one time I had 1.5 billion dollars out of about a 6½ billion budget that had not been allocated that I held here for such fixes as that. And I would only dole that money out as we had to. I think when we established that in about 1965 I think I had used \$500,000 of the \$1.5 billion in reserve when we landed on the moon. To me, that was terrific. When you got in trouble you could really buy your way out and dollars were plentiful. I contrast that to being in trouble and not being able to bail it out and allowing your program to slip, right at the height of your program when your manpower is at its very highest. You slip ^{a day} or a month there and it's mighty expensive.

BS - This was a concept discussed and approved by BOB, Bureau of the Budget and was openly declared as reserve.

RB - I heard a comment as far as North American that at the very beginning North American maybe tended to put some of their better people on contracts they had with Houston because they figured if they got into difficulty on the S-II that the Marshall in-house capability could help bail them out more quickly.

BS - I have no knowledge of any such thing. We insisted from the outset when North American won both contracts that we would have a separation of engineering departments. We would not rely on one department to provide the services for both. We thought both jobs warranted that sort of setup. I don't believe that we had that problem. I think what happened--when we went into the system--it goes back to this fundamental separation of in-house or transition from in-house to out-house we went into the S-II with the idea that... end Side When we started contracting out of house like on the S-II and the S-IVB as contrasted to the S-I and the S-IC Dr. von Braun went into that with the idea that we did not want to get in and tell the contractor how to do the job. He wanted to make him responsible for it.

BS - We we, by choice, elected not to overly penetrate the contractor. As it turned out every case where we failed to do that it cost us dearly. Because having a heavy in-house involvement was almost having a parallel approach to doing the job. When we did not provide that kind of penetration like we did on the S-IC, etc. it really got us in trouble. Back to your other point, I don't, I'm not aware of any such problem.

RB - This was just a comment that was made.

BS - Our problem was that North American was selecting a company for both jobs that were, I think they must have had about 6,000 people in that division. They went from 6,000 to 35,000 in two or three years time which meant that they were just hiring everything that became available--in fact hiring was a problem. And just getting the people on the board was a problem whether they were worth a dam or not. And then getting those people working and functioning as a team is a thing you don't do first time around. That was our big problem, not the other thing. I think it was just a matter of getting themselves staffed up to do the job, getting them organized, getting systems in operation. They too didn't have some of the systems that we didn't have when we started. It was a learning process for them. You don't want to take on programs like Apollo with a learning capacity. If a company had to go from 6,000 - 12,000 that's within their capability to absorb over a period of time.

RB - You compare the LH-2 technology as at Douglas went through stages in that they did the S-IVB and _____ the S-IV. They also were able to rely on Centaur technology. But they had the manufacturing experience, but they were also dealing with a smaller capacity.

BS - I think, again, in a source selection process if one were looking into history of why North American had so much trouble I think you'd really have to assess that. I think we did not have a good exchange because of competition between Mac Dac and North American. I think if we could have found a way of having those people communicate more so you can transfer the technology from one to the other it would a heavy gain. But that's not the name of the game.

BS - I might just mention one thing that I'm relatively proud of. I don't know whether anyone has discussed it with you or not. We had the pleasure of having Mr. Webb, who was NASA Administrator, come into our control room after we had gotten it into operation and he was like a kid with a toy. He thought that was the greatest thing that ever came along. He had come down here for a press conference. He was speaking to a large delegation of people down in the 1st floor auditorium and he had just come from over there. When he got back he had indicated to people that I had just given him a total run-through of how we manage our program, etc. about an hour presentation to him. He called it the most sophisticated form of organization that he had ever, in all of his life, been exposed to and was just loaded up with praise. He could just see how it worked for him.

BS - Since I have heard it said that he had told von Braun, "von Braun, you will make your mark by landing on the moon. I will make my mark by innovating and developing management systems that are the best known to man. That's how I will make myself known." So that was right down his alley and he was totally

enthusiastic about it. He came back three times within a year to hear more about the good stuff. He brought some of the leading industrial leaders. He brought the membership from the World Bank. I don't know how many people he did parade through there either with himself or on special trips. I spent most of my time briefing on that concept of operations. It was a fantastic tool we had. For those who offered a little resistance in the beginning they soon became very strong believers and supporters of it. And I would venture to say that any of them who had to assume the major responsibilities that we had that would be one of the first things they would try to develop.

RB - That _____ is hard to--I'll have to work on this to really try and bring out the premier position it had in crystalizing all this.

BS - It was really the hub of the entire operation. When you get a program as large as the Saturn, as large as Apollo, one of your largest problems is communications, which is visibility. Now if you can get things visible and you can communicate to those other people, and if this fellow is doing something he knows is going to impact that fellow or that fellow, and they all know that which comes with visibility your problems are going to start solving themselves. It's the hidden and the unknowns that normally destroy you.

RB - What really made the Saturn V Program Office unique then. Was the PCC one of the things that really made it unique?

BS - I would hold that as one of the key things, but I think there were several factors. I would start with a man, Art Rudolph. I think he understood the principles of management by some magnitude above anyone that I had ever been exposed to. He was totally appreciative of the need for good communications. If you carried him a letter and you had an excellent content in the letter and didn't have good distribution you got raked just as much as if you didn't have good content. He firmly believed that everybody must know what the other person is doing to some extent. He expected me to know as much about the NASA budget as I did about the Saturn budget. He said that will impact me so I want you to look ahead and know where that is. Communications again. He was very free with his information back to headquarters. He did not try to hold secrets back. He was a very forthright, honest, sincere individual.

BS - Consequently, in this operation that he had, he developed tremendous teamwork between people. He was not competing with people. Let me just give you an example. He kind of made me, if I'm made, by allowing me to really assume a major responsibility in the program. And when it came time to present the control-room concept to Webb you didn't see him standing up presenting it. He said this is my control center and this is the hub of my operation and this is the fellow that is responsible for it and I want him to carry you through it. And I was up doing it. So you get a tremendous amount of satisfaction out of that, and therefore you work just a little bit harder to make it a little better.

You really fed on that. Each person was treated the same way. The Stage Manager was the ~~manager~~^{master} of his stage. He did not try to run it. When we were talking S-IC this was the man up talking. He developed this esprit de corps within the group and in turn within the center and within the government-industry team. All of that developed and matured. He was just a fundamentalist. He did not give himself a snow job. He recognized that it is hard to accomplish what you say you are going to do, therefore give yourself just a little leeway. In other words, if you need a dollar, get a dollar and a dime. If you've got to have performance of 100 lbs. get 101 because things don't always work as you start out to make it work. Keeping it simple was the thing he stressed very, very heavily.

BS - I think his fundamentalist approach was the key to it and appreciation of the significance of that. There were many other things. We had a tremendous technical capability behind us at the center--in the lab. Being able to harness that and make it work with us instead of against us was a thing that he knew how to do best. He was totally ~~appreciative of the lab~~ appreciative of the lab. Where he had to go against the lab director he personally called him, discussed it with him, tried to make him understand and make him a part of the decision. And, of course, that gained that guy's confidence. So instead of fighting all the time he was trying to preclude fights. We still have just many attributes that he had. He was ~~totally~~-dedicated and he expected the same from his people. Time meant nothing to him.

RB - Long meetings, where people would drop notes out the window?

BS - Yes, he had a few of those. But in doing it he went into great detail. We made this conversion of contracts that I mentioned to you. We worked Saturdays and Sundays to do that. We didn't take time out of the regular schedule. We did it in a relaxed environment with nothing else on our mind but that. Whereas we had those things finalized, Houston tried to make it. And at the time of the fire they were under letter contract which was kind of bad in a way that you are caught in that condition. But we thought ours through thoroughly in great detail and when we implemented it we didn't have to change it.