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INTERVIEW WITH REIN ISE
INTERVIEWED BY STEPHEN P. WARING
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1. WARING: Could we start by you giving me a little bit about your personal background. How and when did you get into the space business in Huntsville?

2. ISE: My background, like quite few others, a number of folks here at Marshall, came down to Redstone Arsenal with the Army back in the mid-'50s. I graduated from college at Johns Hopkins University in 1956. I was in the ROTC program and then shortly after graduation I was called to active duty. I went through basic training and then had to fill out an active duty assignment preference form and I told the Army that I would be interested in working in the area of missiles or rocketry that was at that time just becoming a public interest and a number of things was going on in that area, some exciting projects and technology forming up. I really hadn't learned much about the space program at the time. I had read a few articles that had appeared in national magazines, Sunday supplements and what have you, that Wernher von Braun had published. Some of his early papers on moonflight and so forth. Those caught my eye. Anyway, going back to that as a reference, I requested that as an active duty assignment in some field that related to that. I didn't even know about Redstone Arsenal or anything that was going on in Huntsville. Low and behold, this is not to common in the services, but I got an assignment that was right on down the line of what I had requested. In fact, better than what I had even imagined, which was an assignment down here with the ABMA, the Army Ballistic Missile Agency in the fall of 1956. I came down here and was assigned a project engineering job with the Redstone Missile. That particular assignment was related to the production and field support of the Redstone Missiles. I worked in the Industrial Operations Directorate of the Army Ballistic Missile Agency.

Then towards the end of my active duty service, the ABMA organization had

become involved in the space program by virtue of launching Explorer and there were other projects, somewhat more ambitious projects on the drawing table. So, I was real motivated to move out in that directions. I was able to convince my Army supervisors to let me work with one of the design laboratories, the Structures and Mechanics Design Laboratory, which was starting work on the versions of Jupiter vehicle, lunar probes and other kinds of space probes.

So I went to work on what at that time was called the Development Operations Directorate. When my active duty was over then I stayed with that organization.

3. WARING: When part of ABMA broke off to become Marshall did you immediately go over?

4. ISE: Yes. I went with that organization which was a technical organization, an arm of ABMA, which I am sure you know. So I stayed with it. There were a number of space related programs. In fact, the specific program that I was assigned to when I had just terminated my active duty and became a civilian employee in this technical directorate. The first assignment I had was on a new vehicle called JUNO-IV, which was a three-stage, liquid propelled vehicle that was destined to launch a Mars probe. It was a high energy. In today's terms it was a relatively small vehicle, but it was a high energy booster that we were doing in conjunction with the Jet Propulsion Laboratory. The idea was to develop that based on that as the Jupiter as a first-stage booster. Then launch this deep space payload on it. I was assigned the responsibility to be the liaison engineer out at JPL. I spent about three months out at JPL. Then that particular program was cancelled. They felt that money was short and they had other things that they wanted to put as higher priority. So that particular program was cancelled.

I came back and started working on the Saturn I Booster development activity. That had just been approved by the ARPA as a demonstration of the engineer clustering

concept. I and one other fellow, that also had graduated from the Army-related routine, put together the development plan for that Saturn-I booster, that we were starting to do in-house as a demonstration of that concept.

So, that is how I got started. After about two years, I decided to go back to school. I took off a year and went back on my Master's degree and got a minor, if you will, in propulsion. I got the Master's degree from Duke University. I came back and was assigned to yet another new development program called the Saturn-V. I was one of the initial staff on the Saturn-V program. They had in the meantime established an organization called the Saturn Systems Office. So I was the assistant to the Saturn-V project manager in the Saturn Systems Office. Participated in the initial planning and in the establishing of the contract structure and so forth, the contractor structure for building and developing the Saturn V launch vehicle.

5. WARING: Who was the head of the Saturn V Systems Office? Was that Rudolph?

6. ISE: The Saturn Systems Office, no, the original head of that office when I joined it, I think on a temporary basis, was Konrad Dannenberg. Then they brought in a permanent head by the name of Oswald Lange. He was the head of the Saturn Systems Office as long as it was the Saturn Systems Office. Then later it got split into the Saturn I Program Office and then the Saturn V Program Office, because now they had two major programs in it. They decided to split those into individual programs. Lee James became the head of the Saturn I Program office. No excuse me, it was Bob Lindstrom I believe, first. Bob Lindstrom was head of the Saturn I Program Office and Art Rudolph was head of the Saturn V. Then later Lee James replaced Bob Lindstrom.

7. WARING: So your background is primarily in propulsion?

8. ISE: It was propulsion of launch vehicle systems. I stayed with the Saturn V program, I head of the Systems engineering office when the organization started growing significantly. Of course, the organization became more complicated with a lot more boxes on the chart. One of the, if you will, the staff boxes, the staff level boxes within the Saturn V program was a Systems Engineering Office. I headed that office for about a year and a half. Then I decided at that time to make a switch to another new project called the Saturn I-B CENTAUR Project Office. So I went with that and I was the head of the Systems Engineering Office on that. That lasted about six months. Then that program was cancelled. They decided that they didn't want to do that particular job. It was interesting, that was also a collaborated job with JPL that went down the drain.

So we were relieved from that responsibility. About that time, the concept of the Skylab Program was just getting started. At that time it was called the Apollo Applications Program. Studies had gone on for some time on how to utilize some of the Apollo developed hardware on doing other missions, particularly in earth-orbit. Both using the launch vehicle component, using the Apollo capsule itself and developing a long stay-time capability in earth orbit. Then that started jelling in late 1965. I believe it was late '65 early '66, when the Apollo Applications Project Office was established and I joined that. Actually the whole crew of us that was part of the Saturn I CENTAUR became the part of the office.

Then we went through this initial phase of the Skylab program which was called the "wet-workshop" where we were using the concept of the third stage of the Saturn V launch vehicle, the S-IVB stage, launching it and then converting it once it was in orbit to a space station module. Of course, that developed fairly rapidly until the concept of making it a "dry workshop" which means that it was completely outfitted on the ground. It was never used as a propulsion stage.

So we got started on that thing. We went through some initial studies on the wet workshop. Then right up until the time the dry workshop concept was established, the

Apollo Telescope Mount became a major part of the dry workshop concept. The Apollo Telescope Mount had seen some initial study efforts done at Goddard Space Flight Center. Then that was all transferred in the Skylab Program. When it arrived at Marshall it became the Apollo Telescope Mount project within the Skylab program. I was named the head of the Apollo telescope Mount project under Skylab at that time. This must have been in 1967.

Basically that was...we implemented the Skylab Program and the organization and my role in it continued through the mission. Then for the last year of the Skylab program in 1974-1975, after those three missions were completed. I was named head of the Skylab Program and basically had the responsibility for phasing out all of the activities, once it was decided that we would not have any re-flights. Basically [I] did the finally documentation of the program and basically phased the program out.

9. WARING: Were you involved at all in the re-entry of the Skylab?

10. ISE: Yes, that was during that period there. One of the little assignments I had was when....well excuse me, the Skylab itself came down quite a long time later. The Skylab program per Se had been dead for quite a long time. It was several years later.

No, the thing that I was thinking of was during that one year from 1974-75, the S-II stage re-entering. That was the biggest article that re-entered the earth from orbit. I was the Skylab manager at the time and we went through quite an exercise to develop the statistical data and make some predictions and keep the public informed and basically track the thing to define when and where it was going to re-enter. It finally re-entered right in the middle of the night. It must have been three o'clock in the morning. I remember doing night watch, because the center director wanted to know exactly when it re-entered and where it re-entered. As it turned out re-entered somewhere over the South Pacific. Nobody ever knew where it re-entered.

11. WARING: It was a dead-stage though?

12. ISE: Oh yes, it was a dead-stage. It probably didn't have any residual propellancy in it anymore. I am sure that everything had vented out by that time. I don't remember what the weight was, but it was 60 or 80 thousand pounds of weight coming in.

13. WARING: Okay, let's go back and cover in more details some stuff about the ATM. Why did Marshall wind up with the ATM assignment?

14. ISE: There were several reasons, really. One is that the particular concept that had been studied by Goddard, was an early Apollo Applications study, where they looked at the possibility of taking some small instruments, small telescopes and mounting them inside one of the bays of the Apollo service module. I don't know if you are familiar with the way the service module looked. But anyway, one of the bays in a non-lunar mission could be emptied of the expendables. The concept involved putting a little door there for the hatch and putting some size instruments inside and then while the Apollo service module were in earth orbit you could open the doors and these instruments would look out and do science. That was a particular concept that had been studied by Goddard.

15. WARING: That was to look at the earth, or the stars?

16. ISE: The particular thing that Goddard was looking at was a solar mission, which the ATM ended up being and always was. Apparently the solar mission...because the sun is such a bright object and at that time in the history of spaceflight one could do a lot of good science on the sun in a short time. The stability wasn't so important because you could take quicker snapshots, they didn't get all blurry. You could get a lot of data within whatever

Apollo capability was at that time, a ten or fifteen day mission. Therefore, I think, that the initial opportunity, if you will, that the agency announced was for this solar research. There had been some proposals submitted by the science community to develop some of that instrumentation and take advantage of this opportunity. Both investigators had been selected and were working with Goddard to conceptualize this idea of working outside the service module. Well, it became pretty obvious at that time that Skylab, the "cluster concept" was developing. Two things, one is that this idea of utilizing the Apollo service module had a very limited scope to it. It was more or less a dead-end program. The instrumentation was very limited in size. The mission times were limited. It was quite expensive, because it took a whole Apollo capsule on a big Saturn vehicle to launch it in orbit and then you only had room for these couple little instruments. It just didn't take hold. That concept didn't take hold.

At the same time, the Skylab program solved all those problems. It had a long lifetime capability. It had a massive amount of payload capability. Your instruments, fundamentally, didn't have a size limitation to them. In fact, the sciences had started complaining that they had such small solar instruments, that they really wanted bigger instruments. So it solved both the problem of accommodating those scientists that had been selected and getting them basically what they had hoped for. The way to give it to them was under the Skylab program which was managed at Marshall. Therefore that whole responsibility of putting that payload together and accommodating those scientists was all transferred over to Marshall.

17. WARING: I see. Who made that decision? Was it George Mueller?

18. ISE: I think that it was George Mueller. He was the prime mover. It was George Mueller, but George Mueller was only responsible for manned spaceflight. At that time it was, who was the head of OSSA at the time? It was Naugle/Mueller type decision, because

Naugle was really responsible for the science. So Mueller went to Naugle and told him, "Look, if you want to do science, this is the way to do it. I would propose that this ATM be developed with this kind of capability and it looks like this is really what fits your bill." Naugle would say, "Yes, it looks real good and the way to do it is to put it all with Marshall because it has to be more or less integral to the Skylab concept. It all came over here.

I don't remember this real clearly now, but sometimes this happens and I think it happened this time. Goddard had been loaded down with a whole bunch of programs at the time. If I am not mistaken, OGS, OAOs and all those things were really gaining momentum. I think that Goddard was having some problems with their manpower and so forth. So, they were not particularly reluctant to let this go because they ere pressed to handle the projects that they already had. So that was the other reason it came over.

19. WARING: Was there any particular expertise that Marshall had that also was a reason to bring it to the Center? The Center did not have a great background in space astronomy. Was it mainly because the Skylab was here?

20. ISE: I think that is the main reason. But Marshall has always had a pretty good foundation of science capability in the various areas. At that time, I am trying to think, it seems like there was some sort of solar activity going on at the Center. One of the things that had had happened, either just shortly before that decision on the ATM and Skylab, or shortly thereafter, where one of the principal investigators, of one of the instruments that had been selected for flight on ATM, Jim Mulligan, had moved to Marshall. He was down in the Space Sciences Laboratory. I don't exactly remember whether this was just before or right after. I think he was here before.

21. WARING: But he had been a principal investigator at Goddard?

22. ISE: He had been a principal investigator at Goddard. I think when he found out that Goddard was going...I think that is right. When he found out that Goddard was about to transfer, or being asked to transfer it out to Marshall, I think he made the decision to "Hey, I don't want to be hung out here on a limb. I will just become part of the program at Marshall, so I will be assured of being right in the middle of the action." So he transferred to the Space Sciences Laboratory. There were other solar scientists in the Space Laboratory. I will tell you could shed some light in this particular area, he happens to be down the hall here. A fellow by the name of Tony DeLoach. He was in the Spaces Sciences Laboratory at that time. He is back on solar science. He can tell you the center strength in the solar science area at the time. The center did, in fact, have some recognized capability, even though it wasn't very big.

23. WARING: The Center's experience before Skylab had primarily been in propulsion. Your experience had primarily been in propulsion. What sort of new problems were created when Marshall got involved with the ATM? How did this test or challenge the engineers?

24. ISE: First of all, let me make sure, there were really no problems for the Center in taking this assignment and implementing it. Let me explain why that is. The Center had an extensive capability in not only the propulsion discipline, but the Center had done other work in the non-propulsion area. For example the Center was involved in the development of the PEGASUS Satellite. Prior to that the Center had done the Explorer I and Explorer II, Explorer III and several other small payloads early on.

25. WARING: So there was a legacy of expertise that could be drawn on.

26. ISE: Yes, but what I am saying is that not everyone was orientated down this one track.

There were people within this organization that already had familiarity with non-propulsion type assignments. Like I said, starting with the small satellites. Then there was the PEGASUS Satellite. The lunar rover vehicle was done at Marshall. There was a sizable body of non-propulsion within the Center.

Basically, it is more fundamental than that. Things get really down to basic. You worry about structural design, you worry about electronics design, you worry about thermal design, you worry about dynamics, guidance and control. Those fundamental problems, if you are knowledgeable, even though you have applied structures to a large vehicle, there is essentially no conversion involved in taking that knowledge and designing the structure for a solar telescope. Now obviously, it is not one for one, but the fundamental capability is there, and you can make the transitition fairly readily. Sure, you may be faced with some new poblems, but new problems come along in engineering anywhere you are, even in propulsion area. Everyday brings new problems. So the conversion is not that difficult.

What was new was the appreciation of the science itself, that is, the, if you will, the understanding of what the scientists were trying to achieve and the system [that] could best support them. We got support in that area out of some of those folks in Space Sciences Labs, who had insight into the scientific, that particular science discipline that could speak for the scientist. In fact, we established an operation involving Marshall experiment scientist that sort of representative the Principal Investigators that were located throughout the country, that could speak for them here and represent them locally. They were knowledge. He talked with the P.I. and his team daily. He could represent that science discipline back into the project. So they provided that extensive liaison.

Some of us that got into now, into this world of more science orientated activity, if you will, I personally didn't find it difficult at all to start communicating and start appropriately discuss and manage the activities related to the scientists interest.

Except for the one instrument that was actually being developed down in the Space Sciences Lab, of course all of the other instruments were being done out in the universities

and other laboratories. So, the predominates of the science skill per se, did not have to exist at Marshall. We drew from those organizations outside. The program drew from the organizations outside, the needed skills to actually build and test and deliver the hardware.

Now, where did Marshall fit in this picture and what was important? What was important, we needed to provide them with basic requirements, not science requirements but engineering requirements, which was pretty easy to do. And we had to assure that the hardware was properly tested and verified so that we would have the confidence that everything would work alright and we were ready to fly. Again, that is more of a fundamental skill than a specialized skill. One of the key things that ready ATM represented within the Center was an overall systems engineering job. Because the ATM, itself, required a significant amount of systems engineering and integration of a very complex payload which was the ATM. But in addition to that, the ATM also provided the pointing and control for Skylab, as well as some of its electrical power. The ATM team here at the Center, the heaviest involvement here at the Center was really engineering of systems. What systems? The power system, the attitude and control system, the overall structure and so forth for mounting the instruments, providing the proper thermal control and so on.

27. WARING: Was the actual structure built in-house?

28. ISE: The Apollo Telescope Mount provided to the investigators, who would develop and deliver the telescopes, provided them, if you will, a stable optical bench, provided to them a thermal enclosure and protection, provided to them the fine pointing control required for the stability of the thing, and provided them a telemetry signal and electrical power interface. We helped them work out some of the operational issues involved in all but one of the instruments used built for taking data. So, the operational procedures for changing film cameras, protecting the film after exposure, before exposure and all of this.

29. WARING: Were there any particular labs involved in building this structure?

30. ISE: It was a total center effort. When the program started, it appeared that the bulk of the effort would be in the area of frame and control. Therefore, initially, in the very early days of the program, the program was set up on the concept of the lead lab, the Lead Laboratory Concept, where at that time it was called the Astriontics Laboratory, had in it a staff of people, starting with a Chief Engineering for the Apollo Telescope Mount job and he had a staff of people. They were the lead laboratory. But then all the other laboratories were called to participate, like the Structures Laboratory had to design the structure and so forth. Well, it was less than a year after the program started, it was pretty obvious that the lead laboratory concept was not the best concept to use, because, this was particularly true at that time when the original German laboratory directors were still in place. They had a little bit of this fiefdom philosophy where each one ran their own little kingdom. One laboratory was not very effective in being able to, manage other laboratories who also had to participate in a very key way on the whole project. So we recognized that and we moved the Chief Engineer, who was in the Astriontics Laboratory, move him to the Project Office as well as his supporting staff. He started managing the total Center from the Project Office perspective, rather than from a laboratory perspective within Science and Engineering. From that time on things smoothed out and went pretty well.

It was an interesting arrangement in that the Chief Engineer and his staff, even though they were part of the project office, never became administratively part of the project office. They were physically located within the Project. They were part of the Project team. They answered to the Project Manager, but they also answered to the head of the Science and Engineering organization. So in a way they wore two hats. That particular concept is still essentially in effect today. We made a point of physically co-locating that team. We didn't care who actually wrote their paychecks, whether it was S&E

or the Project Office. Everybody was together and acted as a team, physically located together. Today, the principle still is that the Chief engineer and his staff is part of the Project Office, but they are not necessarily located physically together. We got away from that where they were not physically located together, now we have started to going back again where they are actually physically located together. Right here, for example, we are not totally integrated, but the Chief Engineer is in the other corner over there, a few steps away.

31. WARING: As the Center diversified away from propulsion into more complicated systems like Skylab and ATM, they had to work out a new organizational structure at the same time?

32. ISE: Let me make sure that is really... I am not real comfortable with saying that. The reason I am not is because the additional complexity of these larger and more complex programs were recognized even before Skylab. The concept of a chief engineer organization was, I believe, already in place prior to Skylab. What we did here with Skylab is that we applied a particular variation of that to that program that we felt would be most effective because of the way Skylab was run, what it representative, and how ATM specifically fit into the thing. Adapt the ATM because of the large in-house involvement specifically to the....

33. WARING: Where was all the hardware and the instruments integrated?

34. ISE: Everything was done here at Marshall.

35. WARING: Was there a building in particular?

36. ISE: Yes, each of the laboratories participated in their particular area of discipline in design. It was still true that one of the heaviest and most involved in ATM and Skylab was the AB Lab. They had by far the biggest bulk of the design job, because they were involved in electrical power, they were involved in all its telemetry, they were involved in all pointing and control. Those are major big assignments. We did the basic design....now you are talking about the power telescope, specifically? They did the basic design of the Apollo Telescope Mount, there were major elements within the Apollo Telescope Mount, there were procured under contract. For example, Control-movement gyroscopes that we bought from Bendix. The experiment pointing control in-bolts were bought from Perkin-Elmer. The computer, the ATM computer was bought from IBM and so forth. But the structure was designed and actually built in-house at Marshall, by what was at that time the Fab Lab. It has now disappeared. They actually built all of the structures and mechanisms. We adapted the north bay of 4705 to the ATM fabrication and assembly area. There were several workstations there that built up the structures and everything around it and did the final assembly of the instruments and everything. That was for the ATM itself. Then the final assembly, where the instruments came in and were assembled into the ATM and where the final testing and checkout were done was set up in [Building] 4708, in the southeast corner, where we built a large clean-room. Then a much more controlled 10K clean room area for the final assembly and checkout of the science instruments for ATM. That was developed and built at that time.

37. WARING: Where was the ATM finally mated with Skylab? Was that at the Cape?

38. ISE: That was at the Cape.

39. WARING: How did they transport the ATM to the Cape? Did they fly it or ship it in by barge? Do you remember?

40. ISE: I am almost sure that the ATM was flown by airplane, the super Guppy? There was a special transportation built that was suppose to hold ATM and had environmental controls on the thing. All of that was loaded on the Super Guppy and transported from Marshall to Johnson Space Flight Center. The reason it was taken down was because the final thermal vacuum test of the whole thing, the whole ATM, the only facility large enough to accommodate that was the large thermal vacuum chamber at Johnson. So we had a whole large crew of test people who went down to the Johnson Space Center and spent nearly a year down there doing that final testing operation. Then they followed ATM down to the Cape from Johnson. Again it was flown down there. Then they spent about a year at the Cape testing it and integrating it into the Skylab and getting it launched. So there people that were on the road for almost two years to do that job.

41. WARING: That is interesting. You said there was a special transport container for it. Was that a vacuum [container] too?

42. ISE: Yes, it sure was. I am sure you have seen this.

43. WARING: I don't know if I have seen that one, but I will get it.

44. ISE: This is ...

45. WARING: Is that a Marshall publication?

46. ISE: It is a NASA publication. The NASA SK402. We put out a whole series of Skylab documents. This is one of the things that I was responsible for during the close-out of the program. This basically tells you a little about the ATM and the results, particularly in.. A

lot of beautiful pictures.

There is one chapter that describes what we talked about with ATM and what we went through.

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47. WARING: ...I can investigate that a little more. One thing Marshall was known for in working on the Saturn Rockets, and one thing Germans were known for, was their conservative engineering principles. In what ways were conservative engineering principles applied to ATM? Or were they?

48. ISE: Yes, they were. I think very definitely they were. One of the ways that conservatism manifests itself is in design margins that are built into a system. You don't strike your resources tightly. You build more margin. The whole Skylab Program, ATM, benefited from that because we had the capability to lift a lot of weight into orbit. So you didn't have to cut your structural margins that close. You could leave a margin of maybe two or something safety. You didn't worry about too much because there was plenty of lift capability. The same thing with pointing control system, we used somewhat of a belt-and-suspenders approach in that we designed redundancy throughout the system. Every critical subsystem was redundant. We used existing techniques. There we nothing really state of the art, or sophisticated that we use. The control movement gyroscopes themselves were somewhat of a new technology, but again, we ended up using the big heavy wheels spinning at reasonable rates. I think it was 8,000 revolutions per minute, which is pretty high for that size wheel.

But the other thing that one does in the conservatism is the development test approach. The ATM program had a completely separate prototype model which was flight-configuration prototype model, that went through all the qualification testing. [It] went through qualification levels of testing. Then it was later refurbished and was a spare.

The flight model came along right behind it and it was exposed to flight level testing. So we basically had two complete test programs of the whole system. This was true of the instruments as well as the ATM itself. So, we basically built two units. We had available a back-up Skylab for all principle purposes. That approach of having a full qualification prototype unit. We had flight-testing of all the components, which was quite expensive. All of that is part of conservatism.

Of course, at the time we fortunately were able to do that. In today's budget environment, there is no way to put that conservatism into a program. We have to take a lot more risks. You have to design it a lot tighter. You don't usually have money for building second prototype units. Then you sometimes don't do all the things in the testing area that you would like to do.

49. WARING: But Skylab was one of the first big NASA programs that experienced quite a few budget cuts. Was the ATM far enough along that it was less affected by budget cutting than Skylab?

50. ISE: I don't agree that Skylab had budget pressures on it.

51. WARING: It didn't? Nothing in comparison to what came later.

52. ISE: Nothing in comparison to what is today. You know I am sure that the Skylab manager didn't get everything he wanted, but he got almost everything he wanted. The reason for that was because Skylab was still within the umbrella of the Apollo Program and benefitted from that. The Shuttle Program had not really gotten started. So as I recall, NASA was able to put funds into the Skylab and not really be that taxed. Obviously they were careful with how they spent there money. But I tell you, Skylab had the money when it needed it.

53. WARING: Well, that is interesting. I think that you are probably right. That is a good way of looking at it.

What were the legacies of the Telescope Mount for the Center. How did the fact that the Center had built the Telescope Mount affect it later? Were there lessons learned in building the telescope that were applied later? Were there skills that were developed? Did the Center move into new areas and use that as a precedent for branching out? How would you assess the ATM?

54. ISE: I believe there was considerably build up of Center capabilities that resulted from this. Unfortunately, the Agency was in a mode that when the Skylab was completed, there weren't very many major programs knocking on the door to take...for example like I said, we had built this beautiful assembly area for ATM. We build an outstanding 10K clean room over there. Of course, capabilities within the Center in all of these different areas including guidance and control and so forth. None of that was really utilized because there was nothing that followed on the highs of Skylab that was anything of that magnitude. We had to drop back at the Center throughout and go to smaller things for a while. We are starting to work Shuttle, so that of course, was a big thing going on.

What were some of the smaller things? Well, HEAO was one of them. I can't speak for this with real authority, but I do believe that probably the fact that the Center had successfully gone through the Skylab and ATM programs was probably a factor helping get the HEAO assignment to this Center. I don't know that, you would have to really get some of that from the HEAO people. But I believe that did play a role. Of course, the Center had shown its capabilities in working with science instrumentation in putting together complex space systems and being able to do a science mission such as Skylab and ATM was. I think that people felt a lot more comfortable about the Center taking on something like HEAO. Then later on, of course, Space Telescope. I think really one lead

to the other, even though we might have gotten some of those scientists anyway, I think it made it a lot easier for everybody.

You know, Skylab, today, we have these great observatories that OSSA is doing, like space telescope, ASTRO-1 and so forth. Well, Skylab and ATM was a great observatory in that day in that sense. It sort of set Marshall up as a great observatory-type development center, compared to Goddard who was doing some of the more moderate, smaller, specialized missions. I think it sort of set the stage. That is just my opinion.

55. WARING: Is there anything else that we didn't talk about that you think we need to know?

56. ISE: Oh, I could go on for two days talking to you about Skylab! You know. Hell, it was the highlight of my career. It was the highlight of anybody's career that was associated with it.

57. WARING: A lot of people have said that.

58. ISE: Well, why is that? I will tell you why. We have had a lot of time to reflect. It was because the program was from the day the program was defined, until it was executed, and completed was just slightly over eight years. Now eight years is a long time. Not today. Today you are lucky to get a program done in fifteen years. The fact that it was such a compact program. A big, major undertaking, but yet a compact program. The fact that it was successful, even though we had to work our way out of a major problem, it was successful. Those of us that had that reaction, were in from the very beginning of defining the thing, all of the heartaches of developing it and seeing it successful at the end. The whole thing was just wrapped up in a nice, neat package with a bow on it. Then you can go back and look at it and say, "That was it and I was part of that." It is something that is not

so easy to do today. Because, right now here in Spacelab Payloads, I have spent thirteen years in Spacelab Payloads. Skylab was only eight [years] and we haven't accomplished a fraction of what Skylab accomplished. Well, maybe that is not totally fair, because we have accomplished a lot. But it is all in small pieces, rather than... It's the difference between building an Empire State Building and building a bunch of houses.

59. WARING: Another thing that you can tell me about is center rivalry. Did center rivalry effect the way the ATM was built? Did Johnson change designs?

60. ISE: Not ATM. Well, no not rivalry. ATM, there was no rivalry. Once the decision was made that ATM was at Marshall, some people might have regretted the move. But once the decision was made, Goddard basically went on and did their thing. There was no rivalry with Goddard on anything related to ATM. The whole thing was at Marshall. No other Centers really had any real particular involvement or influence on the ATM. The only place that we finally got into this busy of somebody coming in and wanting things changed and so forth, was when the JSC crew became involved and they wanted controls and display and how the thing was run in orbit, and how the switches worked, how the operations worked. They wanted their imprint on how that was to be done. We had a lot of work sessions with them and a little bit of give and take business. They wanted things changed less expensive and time-consuming. So we didn't always, couldn't accommodate everything they wanted.

ATM, except for that little bit, and that wasn't really a center rivalry, that more another discipline coming in and influencing it. In the overall Skylab program between JSC and Marshall, I think there was some certain amount of rivalry. JSC wanted to be a responsible participant in this thing, yet, Marshall had such a huge piece of the total Skylab Program. On the other hand, JSC had the crew and that whole operations. There was quite a bit of that jockeying around. But, the two guys that ran the Programs, Lee Belew

here and Bob Thompson at JSC were good friends.

61. WARING: One question that I skipped over here, what could the ATM do that an unmanned system couldn't do? What were the advantages of the ATM?

62. ISE: I will have to think about that a little bit.

63. WARING: Was the system repairable by astronauts. Were there various things that could be done?

64. ISE: Well, yes, the things that I have already mentioned. A key thing is that the principal investigators had set up it to use film. Because, they felt that film had the absolute best resolution in terms of science data they could bring back. The business of exchanging film cannisters and bringing them back here to the ground, there was no other way to do it. The crew had to be an integral part of that operation. But as far as science is concerned, this is a little bit nebulous.

In the science area, clearly the crew participated in each and every observation. They could see the displays, they could point, they could select targets, they could work with the ground, they could work with the Principal Investigators and easily modify observations. The ASTRO mission that was just completed was a beautiful example of what man can do with working with the ground.

The crew was essential in the ASTRO mission in that it provided the final fine-pointing with their little job stick. We could not have done that from the ground.

In ATM, I think it was a lot the same way. The crew actually with their joy sticks, were able to control the fine pointing of targets. It would have been much more difficult to do from ground commands. Commanding is a very awkward process. You have to set up your commands, you have to verify so that you don't screw something up. Then you finally

send it up there and you have to verify that it got there and if a bit dropped out, you have to do it again. So it is a hell of a lot easier to just say, "Hey Joe, go over two arcminutes to the left." In that since I think that the ATM worked more efficiently than an unmanned vehicle. Just like on the ASTRO mission.

Now that is not to say that unmanned vehicles can't do the science. It depends on how the thing is set up. But given a set of conditions in a complex system, the computer between a man's ears is unsurpassed. It can get the job done quickly and efficiently. Whereas, it takes one hell of a lot of effort to set up the computational capability of programs, the software and all the verifications of everything to get it done automatically.

65. WARING: Could you expand on that comparison that you were making between the ATM and the ASTRO-1. Do you think there are some other similarities or differences between the projects?

66. ISE: By the fact that both of them were astronomy payloads, one pointing to the sun, the other pointing to the stars. The similarities of course are there in the pointing systems, the times-pointing problems, the crew interaction that I just described, were the same kind of things that had to be accomplished in both.

67. WARING: Were some of the same people that worked on ATM worked on ASTRO-1?

68. ISE: That is an interesting thing. Yes, there were, but because of the time that has pasted, most of the people that worked on ATM are now on a different level in the organization. We don't have such a direct hand in today's missions like ASTRO. But, yes, there was obviously some heritage there that helped on ASTRO. But it is interesting that today, on the ASTRO mission the other week, that mission was run by a bunch of

youngsters. In fact, some of them were still in high school when the ASTRO was originally supposed to be launched. You know ASTRO waited around for four years. That bunch of youngsters did it, did a fantastic job. Surprised some of the old-timers how well they did.

69. WARING: There was a big thing made about how ASTRO-1 was the first real mission-control operated from Huntsville. What role did the Huntsville Operation Support Center play in regard to the ATM? Was most of the control through Houston.

70. ISE: The Huntsville Operation Center was a satellite center to Houston during Skylab. I believe, I am almost sure that back in those days, the way the system worked we were not able to talk directly to the crew. We had to go through Houston. There may have been one or two exceptions, where during off-hours there may have been some more or less private conversations. But I think that all the work, fundamentally, went through Houston.

There is a difference. The following difference: on Skylab the crew consisted of professional astronauts. Some of them were pretty good, both Owen Garriet and Ed Gibson, who flew on Skylab had science and astronomy backgrounds. But they were fundamentally professional astronauts. In the ASTRO mission, the two payload specialists that flew, Rob Frieze and Durance, are not professional astronauts. They are professional scientists who happened to get some extra training to allow them to fly.

[tape turned off, then back on]

71. WARING: You were telling me about how the ASTRO payload specialists were professional scientists.

72. ISE: Oh yes. So, the way things developed on the ASTRO mission, I think, that mission would have been in big trouble had it not been for the fact that we had astronomer

scientist on board talking to the alternate payload specialists about astronomer scientist on the ground. Both of them were totally expert in the science that was to accomplish, the targets they were to look at, how they were to look at. They were able to talk these directly. If that had not been the case, we ended up with about a 67% success ratio on ASTRO. If that had not been the case, I think that we would have been under 50%. We would still have good data, but probably under 50%. That's different from Skylab, because we didn't really have a scientist to scientist relationship set up.

73. WARING: Did the Center fight to fly the second Skylab?

74. ISE: Well, I don't know that the word "fight" is appropriate, but we certainly encouraged that and were very interested in doing it. The problem with flying the second Skylab was that the Shuttle was really beginning to take momentum requiring much of the available NASA funding at the time. But the real killer was that we had been very successful with the first Skylab. We got a lot of good data back, more than anybody had hoped. There was not the time nor the money available to complete the revamped Skylab to bring in totally different science. It was basically just a reflight to get more of the same science.

75. WARING: And that couldn't be justified?

76. ISE: And that really couldn't be justified and the risk of trying to do it again for the same science and possibility of failing the second time around, where you had been successful the first time, would have been very difficult to explain. So the problem was if Skylab had been revamped to where a new set, a different set of Science, if ATM had been eliminated and a set of like, these ASTRO telescopes had been put in ATM place and other new experiments and such, then I think a re-flight would have been order. But there

was not the time or the money to have just an extensive revamping of the Skylab mission.

77. WARING: One question that we sort of hit on indirectly, but let me ask this directly. Were there lessons that the Center had learned in managing the Saturn Project that were applied to building Skylab?

78. ISE: I think the answer is yes. You always learn and applied new experiences the next time around. Not every lesson is applicable because your conditions in programs change from one program to the next. Even though it might have been just exactly the right thing to do on Saturn, it wasn't necessary so on Skylab. So you always have to reevaluate what you are doing and make sure that it really applies.

I think the area that you touched on before, the business of managing large programs the way that you set up development teams with capable contractors being key members of the team and how you establish your whole design review process. Develop a plan with a design to review processes and formality of conducting these uninterviewed processes, the concepts of the requirements to review PDR-CDR sequence. I think those were set up during the Saturn days and are now still applied to large programs.

The Center now follows very faithfully the formula established for this process, and what is accomplished in each one of these milestones.

79. WARING: Did you have an equivalent for ATM or for Skylab something like the Saturn Control Office with all the Gant charts?

80. ISE: Oh yes, oh yes, oh yes. We did that. The Saturn/Apollo program of course, went really all the way on that approach of PERT charts and Gant charts and control schemes and so forth. We started applying that in Skylab, but I think that we modified that somewhat. We grew away from PERT and used more of the Gant-chart approach and

modified it to the situation. But, yes, there were some rather elaborate program control systems in place on Skylab that pulled all the elements of that program together. We still do it, but with smaller programs you devote less of your total resources.