INTERVIEW WITH WALTER HAEUSSERMANN
INTERVIEWED BY STEPHEN P. WARING
HUNTSVILLE
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1. Waring Could you give me perhaps a brief overview of what you regard as some of the highlights of Marshall's work or your work in the Apollo program in the 1960s and those are some of the things we can explore later in the interview?

2. Haeussermann Alright. As you probably know that I had been responsible for the work in the astrionics laboratory and as such had various assignments. First the OR electrical system, the total measuring and communication systems, and the power system onboard and control of the environment.

3. Waring The power assisting and electrical supply?

4. Haeussermann The total electrical supply including the controls and controlling whatever was necessary for the three stages.

5. Waring Alright. To begin our exploration from there, could you tell me what the astrionic lab was like in say the peak of the Apollo program. Let's say I was a visitor to the center, and I came to your laboratory. Could you

describe the expertise of your personnel and the sort of the facilities you had in the lab?

6. Haeussermann We had done a lot of in-house development, generated all the systems I mentioned before and earlier other programs [22?] and in [22?] program and then of course in the first space launch vehicles for explore and similar types which were launched, Juno I and II. The personnel had a lot of experience from their time and based on these experiences we had a full confidence that we can go to launch in orbits like the Apollo program demanded it. My problem was the considerably lots of engines for their power environment and control environment which fueled the engines and for this service you had the [32?] to go along still was the underload system because at that time we hadn't develop for this it was not yet possible to carry out extra control for say electrics. With these problems, we had some problems indirectly. For instance, the F-1 engine had no high pressure pump outlet as it would have been very desirable for several [39?]. We had to be satisfied with low pressure to the pumps and had to use [40?] for the [40?] that went. The [41?] had to be in cross-section and this section much larger for the lower worker.

7. Waring You were using the pumps in effect to control the engines?

8. Haeussermann The hydraulic power for the [43?].

9. Waring I see.

10. Haeussermann You could not have an extra high pressure pump attached to the engine. This was really an oversight, as I was told, in the development and there it was impossible to edit. It meant an inconvenience for several [46?] as I mentioned already they had to be considerably larger, and we had to control those still with a small time constant. The time constant such as this is given by the response of the [49?], the compulsors. Then you have a larger system and want to have the same control frequencies and response, then it means you need more power. This was a very general thing, additional problem had not foreseen at the beginning. Back to the guidance and control system itself we decided from the beginning that the guidance system which doesn't have to have a high response rate can be done individually and activation system, actual control system, was [57?] analogue. We just didn't have the means in the early '60s to develop.

11. Waring Computing technology was not . . . .

12. Haeussermann Was not yet advanced so far that you could carry it out completely. For the guidance system, it was very clear it could do it so we selected at that time IBM as

our support contractor and this was a very happy choice. It gave us excellent training for our own people who did not have to some extent enough experience yet for [64?] systems and we very successful here to achieve a system that had in addition to its direct computation or its capability to use straighter modular advances. This redundancy paid really off in our opinion at that time because nobody trusted with the electronic [69?]. The strange thing was that not in a single case during flight of any Apollo [71?] that redundancy had to be used. We had the information about there was a switch over to a redundant channel or an inclination of a redundant channel. So we had only one case of [74?] checkouts and this was ours.

13. Waring The system never failed so the redundancy . . .

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14. Haeussermann It never failed in any respect. Actually we could afford to have more redundancy in the systems in the computation way but also to build in redundancy retrospect to the gyroscopes and it would have had gyro failures, it could derive similar information from the gyros themselves. It could have certain interruptions of the signal. It could have through extra polation as a way to continue the flight at least so long as the astronauts would have been able to escape. The reliability which I [82?] you'll find of the redundancy was most important to us and

clearly challenged us to put it in wherever possible. This was accomplished without penalty wether acknowledged relatively cheaply in work was spent to volume and base and that was the accomplishment. Even on the analogue computer side we built quite a redundancy and this led to very high confidence that we would succeed without any failure which was actually was proven later by all the flights.

15. Waring You mentioned earlier that you had very experienced personnel because there had been in-house development in the missile programs in the '50s. You hadn't used a major contractor for the guidance and control systems?

16. Haeussermann Oh yes. We had used already Stalling, who worked for Redstone contractor claims, to copy our designs and give a lot guidance and control system. Sometimes not enough to our satisfaction. We switched ones over and when we went later and actually when switched over into Bendix operations, it was elected initially leave of [98?] and we found advice to stick with this component developed there. Bendix went along with our in-house progress and development work and group continues their persistence. We had finally to select, because of the versatility of the environments in flight, we had to select Gimbal system on a stabilized platform for the guidance system instead of the intra gimbal system that we had used on all our missiles before including

Pershing, but we were able to use all the components of Pershing, like gyros and xorometers on this [107?] arraignment of external [109?] systems. Bendix was a company selected again for this work, and they did the same excellent work as before in the missile business.

17. Waring So, Bendix was working in the Saturn project.

18. Haeussermann Yes, they worked their assignment of just the guidance exchanging components.

19. Waring On the Saturn Instrument Unit, that was also largely designed in-house. Is that correct?

20. Haeussermann The components, yes [117?]. But you found it very soon necessary that we had to have a company that is able to build the instrument ring. We selected for this purpose again IBM because they had the responsibility for many of these components and they then make the design or integration of all the components with our help.

21. Waring That was all done here in Huntsville.

22. Haeussermann That was one of the prerequisite to work closely with such an individual contractor and IBM was willing to have its own facilities here where they would build up the instrument unit.

23. Waring One issue that I came across is, it has to do with the guidance and control systems, communication systems in the command and service module. The instrument unit in the launch vehicle was another system. How was it worked out to have, how was the technology and systems divided between Marshall and Houston.

24. Haeussermann Houston of course had the complete responsibility for other control for the command module whereas we had the responsibility for the launch vehicle and the instrument ring which are much defined as the brain of the launch vehicle was our responsibility. Of course the astronauts had a strong desire that if anything would happen them that they have overriding control or final control even of the launch vehicle. So in the intern [141?] agreed that we provide them with all the information they need and capability of a switch over which would have enabled them hopefully to keep the vehicle on its path at least for an escape. This was done and it helped I think you will find Apollo 13 that we had the lightening striking the vehicle.

25. Waring Apollo 12 maybe.

26. Haeussermann It was? OK, 13 we had another accident. It was 12.

27. Waring Right.

28. Haeussermann On 12 we had [148?] situation. Lightening struck, and I think it speaks for itself. Launch vehicle and guidance and control system didn't suffer from this. Command module just went virtually out of control and lost its alignment so in the earth orbit following the ascending path, the on-board launch vehicle control system was used, the information up there was used to realign the command module. This was done through the same communication information as the astronauts would have had their overriding capability in case something happened on the launch vehicle control accidentally.

29. Waring That's an interesting story. I heard about the lightening strike and the failure of the command module, but not the realignment. That's very interesting.

30. Haeussermann That was very interesting. I can't tell you this story. You probably had heard the name of Dr. ? Miller.

W: Dr. Miller, yes.

31. Haeussermann Before we had the first launch, he was the guidance foreman, he told me that I overdesigned the system. I could have built the system cheaper. At that time I gave

him only the answer in my opinion I could not have it much cheaper, but he [168?] for the total reliability of the system and accuracy through gains brought similar work of POGO inspections and selection of components and testing. This makes the system relatively expensive. You could say about 50% of the cost of the stabilized platform is due to the final testing. As for the accident on Apollo 12, I saw on the launch pad Dr. Miller and said, "What do you think now about our systems? Do you still recommend, claim I should have built it cheaper?" He said, "Please be quite."

32. Waring That's a good story. I'll use that story. I have read in one source that Houston did not want the redundancy originally, that Houston originally had wanted the control system for the whole vehicle in the command module?

33. Haeussermann For including the control of the launch vehicle.

34. Waring Including control of the launch vehicle. Is that correct?

35. Haeussermann Well there was some trend or some desire let's say, put we proved and very quickly that this would be a too complex matter and it would have more reliability if it would have a separate control system. Still there were

communications from one system to the other for a need for redundancy. We were able to convince them of this.

36. Waring Right, it was the redundancy argument, the safety argument.

37. Haeussermann Yes.

38. Waring Very good.

39. Haeussermann That means of course including things simplification in the whole checkout at the launchpad.

40. Waring Could you explain that to me?

41. Haeussermann Well, when you have to have the whole system in operation, it take you usually much, much longer and is more complex to check out a system that has these, without the redundancy features and is . . . .

42. Waring So if you had two systems you could check out . . . .

43. Haeussermann Each for itself.

44. Waring Each of itself.

45. Haeussermann Otherwise you would have the one system all the time completely and this takes considerably more checkout time. Such viewpoints came in here too.

46. Waring OK, very good.

47. Haeussermann See we had on our stabilized platform, a total check out time first limited to one thousand hours. You might think that ridiculous, but that's the way we wanted to have it for a solid check out. Some of the stabilized platforms waver because we were exceeding the one thousand hours. Closely you could have argued shouldn't you have replaced the stabilized platform because the ground rule was it should not have not more than one thousand hours. The operating time in the combined systems, the control from the command module of the total checkout would have had much much more operation time.

48. Waring Right. You mentioned the testing of the systems. How was the system tested?

49. Haeussermann That started with the individual components as the manufacturer of these components in transfigure of the stabilized platform. Bendix tested those already in their facility up in [221?] facility. We tested the system here in a repetition form in the laboratory.

50. Waring Did you test the components or subsystem level or both?

51. Haeussermann Both. We tested the components on special test stands. Then when their component was delivered, it was checked out with the connecting system, and its control system received its control command, its guidance command, it was all assimilated in the test facility here and after this, the process was repeated down at the Cape.

52. Waring Was it possible to, in the systems test for the overall test for the instrument unit, were you able to sort of run simulated flights? Did you have some sort of computer system for doing that?

53. Haeussermann Yes. Already in our laboratory, now this is not so much true for the stabilized platform, but for the flight computer. We tested the flight computer in our simulation test facility with the complete program which we had generated for this purpose.

54. Waring Did your lab run that pretty much on its own . . . ?

55. Haeussermann This was done here.

56. Waring The Computations Lab or the Test Lab were not . . . ?

57. Haeussermann No, the computation was not involved. The computation lab was only, at that time, for the aeroballistics laboratory where the flight had delays was necessary to determine the coefficients which we had to put in the flight computer and with this then, we flew our test simulated our flight tests in the guidance and control laboratory or the astrionics laboratory and use for this a special combined analog digital computer.

58. Waring OK. Let me see if I have the division of labor down between the aeroballistic and the astrionic labs clear. The astrionics lab was building the guidance control system.

59. Haeussermann It was turning out the hardware.

60. Waring You were doing the hardware.

61. Haeussermann Yes, but then we received the guidance equations from aeroballistics laboratory, they had done of course their computation level opinion. They had made all the necessary flight test computation regarding complications like wind disturbances uncemetries in the buildup of the rocket, small misalignments of the engines and all these things were done first purely in the

computations laboratory for various inputs for wind conditions and from these thousands of flights simulated there. Then was computed what kind of precisions are necessary to put into the quidance equations which were then to be fulfilled by the guidance computer on board. In other respects like the control system itself, everything was done less [271?] laboratory. We received just the aerodynamic coefficients including polarances from the aeroballistics laboratory, simulated this in our computer to check the control efficients were able to fulfill all these requirements.

62. Waring That's very helpful in helping me understand what the role of the those two labs were.

63. Haeussermann I should say that you should have anther information. Very often, there were efficients from upper systems that were not very easy to realize and that's where we had a lot of negotiate between aerodynamics laboratory, the guidance laboratory and our own laboratory.

64. Waring That's where the interdisciplinary teams were meeting and solving differences.

65. Haeussermann Right. This was especially a good feature we had in our whole team that we went in together to negotiate what is the optimum solution considering the

requirements and [290?] the science sizes, size for the hardware, the size for doing what was most economically with respect to the computations.

66. Waring That's a good example I can use to illustrate that matrix organization or team work effort where there were specialists of different labs. We talked about a lot of these questions. Maybe we can go back to an aspect of testing. Through the flip side of testing is that often you test, well maybe I should just ask you the question. What was the purpose of testing? Sort of what I'm getting at . . . .

67. Haeussermann Sure of course that the components fulfilled their requirements. Then in the action of components, when they are put together, the instrument unit for instance, then they work together as expected. There was not any mistake made in the commands in achieving certain limits that certain responses that didn't work overly that we found out. This is the program that is [315?] or is it a [315?] mistake. We went through the exercise with all varieties of conditions. This was mainly the problem on the assembly. This checkout of the instrument unit was done in the [321?] test laboratory.

68. Waring [322?] (I think this is the same name that I'm not getting from the tape. SK)

69. Haeussermann You've probably seen him too.

70. Waring No, I haven't talked to him.

71. Haeussermann I think it would be good if you would contact him on this because this testing was his responsibility.

72. Waring He was in the quality assurance lab?

73. Haeussermann Right.

74. Waring The test lab handled the engine tests, right?

75. Haeussermann Right, including the over[328?]ation and so on. It was the assurance lab that took care of the requirements as soon as the system was assembled, that all the functions could be fulfilled as requested and there was not a surprise by computer glitches or program glitches.

76. Waring Why was there a separate lab for handling that sort of test. Why not just use your own people for running those sort of tests?

77. Haeussermann Because this was a response [338?] laboratories. For instance, our responsibility was not to

include certain control of the engines. Let only controller or engine controller of the engine, especially sequencing and so on. However, the signals came from the same types of control computer that controlled was its universal capability or set a flight path. These various functions were basically controlled or checked out in a separate laboratory that was independent in its judgement and reported directly to Dr. Von Braun. This was another assurance that there was not a camouflaging or shortcoming. By the way, we had the same [352?] carried out for our company, the way they built the system. The check out was supervised by all these companies by the same people who did, who were from the quality assurances lab and who would report to Mr. [357?] This was request originally as far as I can remember by Dr. Von Braun. He wanted to have complete and separate checkout, final checkout besides the checkout in Huntsville, besides the checkout at the Cape. We wanted to have everything checked out to see it was perfect for the deliveries to the cape on the launch pad. [name 364?] had this assignment . . . .

78. Waring Is he in Huntsville?

79. Haeussermann Yes, he's not far away.

80. Waring Well maybe I'll give him a call this week. I didn't realize his was even still alive.

81. Haeussermann Oh yes. Actually he will be [368?] Wednesday morning.

82. Waring Wednesday morning. And where is that going to be?

83. Haeussermann In the main conference, on the ground floor in 4200.

84. Waring OK. So it's a Marshall panel.

85. Haeussermann Yes.

86. Waring Well I'll see if I can find out about that. Maybe I'll go and maybe I can talk to him there.

87. Haeussermann He might not have time there. You better contact him . . .

88. Waring I can arrange a separate interview, but maybe I can go and perhaps make an appointment with him. Maybe I'll go to that. Is he writing? It might be good to get him out of the house. Who is running that? Is it an in-house thing or is it a public relations thing for Marshall?

89. Haeussermann If you don't mind, I'll get, these are the invitations that I have.

90. Waring I'd like to see it and then I'll know who to call.

91. Haeussermann I have to go to my little working room in the rear behind the greenhouse. I have a separate room.

92. Waring OK, I'll turn it off and I'll wait. [tape off and then back on] Just to follow along with that same theme, one of the major decisions of the Apollo program was to go with an all up flight test for the Saturn V. That was a decision made by George Mueller. Could you describe the initial Marshall reaction to that decision?

93. Haeussermann Well we consider quite risky because it was somewhat detrimental to our experience to make a flight test step by step. We couldn't argue much because Dr. Meuller just insisted on it. The alternative was if we have a failure early, then we can take care of it. But if we were to go step by step, then that would mean delay the whole program so much that it would become very expensive. He said he was willing to take the risk and he was right.

94. Waring When the decision was made, did Marshall consider or attempt to convince him otherwise?

95. Haeussermann There was of course discussion back and forth, but he was very strong in his opinion that we should take this risk, what we considered as a risk to [416?] and that's what we did! Finally [417?] that we went along with him.

96. Waring Were there meetings at Marshall with the laboratory directors and the program managers?

97. Haeussermann Definitely yes. It was discussed of course in our board meetings with Dr. Von Braun and as far as I remember, nobody liked it very much, but they had no other choice.

98. Waring When you say that you had no other choice, what do you mean by that?

99. Haeussermann Dr. Mueller insisted that we do it.

100. Waring He just insisted. OK. So the boss said we're going to do it this way.

101. Haeussermann Exactly.

102. Waring That's interesting. Maybe change now to another important decision and that was the decision about

the mode for going to the moon, whether to go direct descent earth orbit rendezvous or lunar orbit rendezvous. The historical record on this is a little unclear and among historians there is some controversy as to how the decision developed. So the first question is a pretty simple one. Was there a Marshall center position about which mode was best? Did the Center have a series of meetings and then decide well, we believe a certain mode is the best way to go?

103. Haeussermann I do not recall specific meetings on the subject. I remember there was a meeting in Houston after most of the decisions had been made where the question came up to the need for instance the possibility of so much earth orbit. When we reached its own and the necessity and something would come up [453?] as needed an additional orbit for the realignment for the command from the guidance control system or couldn't we go out directly without of orbit to save time. This was our particular involved in this. I was indirectly because we had at that time no experience yet what would be an acceptable [460?] in the 0 gravity for the period of three orbits. Wouldn't this cost too much misalignment of the guidance and control system especially on the stabilize platform. From this viewpoint, I had suggested to go as directly out to the moon since you had always been able to keep our launch time exactly, those corrections would have been necessary on the way to the

moon. So the result was Houston didn't like it. They wanted to have this earth orbit, I remember a maximum of three earth orbits. They succeeded in that respect. Earlier, considered method of flight staying in earth orbit or assembling in earth orbit and going out from the earth orbit was the desire as far as I remember of Dr. Von Braun because he had the viewpoint of one day then you go further out to the [480?] when such a feature is better if it's taylormade just for the moon.

104. Waring Be more flexible, allow for more growth. That sort of thing.

105. Haeussermann Right, yes. That's what he had in mind, but the cost viewpoint and the time already reached, we had to fill up the system to go to the moon. Was quite an argument here. So it was done most economically. This was mainly presented by Houston and we went along with it.

106. Waring So the earth orbital methods of assembling or perhaps launching two vehicles and rendezvousing in orbit, that was mainly an idea favored by Von Braun rather than the Center as a whole?

107. Haeussermann Well, I would say the Center as a whole went very much along with Von Braun. There was never any

controller in this respect, but the final choice, we had to respect the economical viewpoint and the time viewpoint.

108. Waring Right. There is information that one reason Von Braun decided to support the lunar orbit rendezvous, the method that was eventually chosen, was that Marshall was promised a role in building a lunar logistics support vehicle and that of course was never built although a lunar rover of course was built. Do you recall anything about this lunar logistics support vehicle influencing his decision? It appears that this was an idea that was largely playing in his head rather than involving the whole center.

109. Haeussermann Could have been.

110. Waring OK, that's interesting. When the lunar orbital rendezvous mode was chosen as the most economical way to do, what was the reaction among laboratory personnel?

111. Haeussermann Frankly we were not too much involved in this because it was my responsibility of the Johnson Space Flight Center. Our responsibility terminated with delivering to the command module the necessary checks and [530?] into the transfer flight to the moon. That's the way it looked at that time. I guess you know we had afterwards being able to add a few little things like impacting with

the launch vehicle or the fourth stage actually to simulate moon phase. Have you heard about this?

112. Waring No.

113. Haeussermann See, originally our assignment was just to align the command model and the capability to continue the flight to the moon. The fifth stage of the launch vehicle just would have run this phase around the moon also. Then, after the first or second test flight to the moon, the desire came up to test the instrumentation for the composition of the moon through some arbitration moon phase. So the question came up couldn't you impact the IV stage on the moon which of course was a new requirement within providing system.

114. Waring So you were thinking of building a new piece of hardware to fit on top of the third stage?

115. Haeussermann All [558?] you can do this with available components, maybe a little bit more fuel for control, for the alignment and correcting the flight data and also the computation had to be programmed into the computer. This was done.

116. Waring Somehow I vaguely know something about that. What was the project called? Was this part of the regular flight?

117. Haeussermann I don't remember we had a special name for it. We just had to . . . .

118. Waring You just did it.

119. Haeussermann We just did it.

120. Waring Was this part of one of the manned lunar missions? Which one? Do you remember?

121. Haeussermann Third or fourth. I couldn't say [575?].

122. Waring Basically what they were doing was directing the SIV-B stage into the moon.

123. Haeussermann Into the moon.

124. Waring Well I'll do some reading about that. That's worth a couple of sentences anyway!

125. Haeussermann We [581?].

126. Waring It seems like I can remember that, but gosh there's very little information that I've read about it in the course that I've hit on. There's probably a report somewhere. I think we've gone through these things. When you talk about Dr. Von Braun as Center Director briefly, we have lots of quotations and descriptions of him. Could you describe what he was like as a manager of the center? What were his main qualities?

127. Haeussermann On top of all, he was a marvelous systems engineer. He combined what the laboratories had to do, saw that there was not any problem in the being. Of course, Dr. Rudolph who was then assistant manager had [607?], but Werner Von Braun always kept track that the laboratories worked closely together to have an optimum system. He had to understand and be familiar with details to such a degree it was often amazing to me. He checked how far could see assimilation requirements of my laboratory and supported whatever we had the group [621?] to support or where we had to completely tell him no we can do it without it. He worked with it but wanted to understand into less detail our argumentation. So far, I admired him especially because of all this and he did this by getting his on information on various sites so that he had a picture as complete as possible. In this respect he helped [turn tape over 632]

128. Waring You called them board meetings.

129. Haeussermann Each separate board meetings with two aspects. One, administrative aspect where financial information, program information was discussed and afterwards there were testing problems that bothered us. Including of course were objectives from Headquarters. Everyone from the laboratory had to report about work accomplished, to be done within the time frame to be on schedule. Don't forget, we were always told, every day's delay on launch you are not ready with your components and cause a delay and costing a total of two million a day. This was, let me tell you, a push to check our own programming for being ready in time.

130. Waring When you say, delay, does that mean on the pad, or the whole Apollo program? If the vehicle was one the pad?

131. Haeussermann On the pad.

132. Waring So once the vehicle was rolled out, he didn't want to have . . . .

133. Haeussermann This means that this was automatically causing a delay of the next vehicle, but just the one which was there.

134. Waring Right. I understand that. In these weekly meetings, could you describe the atmosphere of the weekly meetings. Were there formal presentations or was it more informal interchange?

135. Haeussermann Both.

136. Waring How long would they last?

137. Haeussermann Usually entire morning. From 9:00 until 12:00.

138. Waring What day of the week were they normally on? Did it vary?

139. Haeussermann I can't remember!

140. Waring These are details historians like to know.

141. Haeussermann I couldn't say for sure. I believe it was Wednesday, but I'm not absolutely for sure.

142. Waring How many people attended them? Was it the program managers and lab directors?

143. Haeussermann Yes, and then of course in addition, he would invite people on certain subjects to confirm,

especially if we had a certain problem to present then we called in our specialists.

144. Waring So what are we saying. Maybe thirty or forty people?

145. Haeussermann Yes.

146. Waring Was information from the weekly notes brought up in these meetings.

147. Haeussermann Yes. The weekly notes had to be sent so they were there by Monday.

148. Waring People would have time to read them by the time of the next board meeting. I've heard the story of Von Braun and the bottle of champagne. Is that a true story or is that just a story that's just been repeated over and over or is it hard to know?

149. Haeussermann There is a book out, I never really have seen this, by one of the Washington people.

150. Waring McCurdy?

151. Haeussermann Yes. I gave him the story and he distorted it.

152. Waring Well, tell me the story!

153. Haeussermann I do not understand why, but what he made wrong was I told him at the end of a fellow who was concerned about this, to deceive the public that he wanted discused anymore.

154. Waring Right, it's embarrassing for him.

155. Haeussermann It's embarrassing for him and he doesn't want to hear it anymore. And he wrote in this book but he says it is not true, and I have now idea why.

156. Waring That McCurdy, the historian, wrote that it wasn't true.

157. Haeussermann That fellow that was involved in this matter said it wasn't true. That is what he wrote. That is just not so. I know the fellow very well and he never said that.

158. Waring Could you tell me the story to make sure I get it right. I don't need the persons name.

159. Haeussermann I think the fellow doesn't want to have it repeated anymore. That is, you bring me to a delimna.

160. Waring Well, I can just use the story from McCurdy then, because I have the story from McCurdy.

161. Haeussermann I will give you a little of it. We had a lot of test failure, sort of a escolage of failure. We had the control systems went out of control and we had studied the records when it came to my mind that the whole control system had received the signal but far too large. This never had happened. So I went into there . . . .

162. Waring What do you mean by too large? Too much power, electrical power?

163. Haeussermann To much conventual surveying.

164. Waring I see.

165. Haeussermann Such a various collection, and the veins did not have much left of their control power of their control range. I went to the fellow who was involved in the last checkout and do you know at this time, it was very early in the flight testing. At that time, he moved from Huntsville down to the Cape and checked out, our engineers checked out ourself and everything was alright. I said to myself, something must have happened there because in the strangest second there was a control gain signal changed

automatically as it should have been, but it changed so that there was too much pressure going out. It looked like a misalignment, an internal misalignment, in the control system. So I went through the whole diagram, the electrical diagram, through my own computer. I went to the fellow in my laboratory and said to him "I would like to see you about be it possible that a zero adjustment was not working well and therefore from the beginning we have the control gain sector was small [710?] and later this was increasing in the 22nd separating. He says, "I just wanted to see you. I came to the same conclusion. I was up there and after the last test I thought I tightened the screw a little bit more on the second adjustment. Unfortunately their system they had the single cap on it was too coarse and winded up the cord. So the tightening of it, you got another zero, not zero [717?]. It should have been in the zero position. Just by tightening this screw, which was against the law after the last test. So the last test says you should keep everything untouched. So he felt guilty that he had done this. It was the best of him opinion from the [721?] that this has happened. So Director Von Braun then told him what he recognized as the source of the mishap. Sure enough, he was happy about learning about learning this. Never said a word, you shouldn't have done so and so, and in a most colloquial way he said "I appreciate that you let me know and just take care that this can not happen again." That was it. Then he said, "How about a bottle of champagne."

And that's what he did. He was so relieved that he learned something from this blight and that it was clear that it was not anything basically wrong.

166. Waring Do you think in the pioneering days of space flight that that was an attitude that people had towards failure? That a failure was an opportunity to learn something?

167. Haeussermann I think so yes.

168. Waring Some people have said that . . . .

169. Haeussermann Yes, I had for instance in my own laboratory an apology. The fellow came with an idea which I had in my own experience wrong. It doesn't take too much time to try it out in the laboratory. I told him. There were cases where due to new technologies, you could go another way. Very often sat back and said "Oh I should have followed your advice, but I gained a lot experience." I was always in favor of that you would gain new experience if it isn't too expensive. This was a method Dr. Von Braun had also. He was very open minded when it came to proposals. Very often he would say, well let's go in two directions and let's find out which one is the best. You had to do laboratory development.

170. Waring The Saturn budget allowed that.

171. Haeussermann Right.

172. Waring Very good. These are some helpful stories. What would you say was the highlight of the Apollo and Saturn years?

173. Haeussermann Well, it was challenging to move from flight to flight. Of course the highlight was the very first success.

174. Waring The first Saturn V?

175. Haeussermann The Saturn V. Then going to the moon was a challenge, on the moon. That was the highlight. But from there on, you always had additional challenging problem. For instance, the lunar roving vehicle because that would be very helpful up on the moon. There were always great problems and lots of payload problems about what could be bring back from the moon. From the beginning, you had designed a vehicle not all [759?] . Now we had a lot of good luck. Here again, I'm going to use Dr. Miller again about accuracy of the guidance and control system. The following happened. We had originally on the request of Houston to plan for an accuracy which demanded, or allowed six flight test corrections on the way after separating from

the fifth stage to going to the moon. That means that you would have had a relatively wide stretch as you see today for your guidance and control accuracy.

176. Waring A wide tolerance in which you had to design the system for.

177. Haeussermann Right. Dr. Mueller had [760?] blaming me that I had built the system to accurate also. At the end, on the last flight of Apollo . . . .

178. Waring 17?

179. Haeussermann 17. We had a little over the fuel demand of 1.5 corrections as originally planned. We found this out very early, the very first flight, that the [775?] would not need the fuel and the capability of corrections to go to the moon after separating of the launch vehicle. That means you could reuse either way, the base [777?] because actually nothing else in [778?] the rate of this fuel. You could do it by far less.

180. Waring Is this in the S-IVB stage or the service module?

181. Haeussermann That was in the service module.

182. Waring The service module.

183. Haeussermann Because the service module corrected after separating of the flight path. This was very, very efficient and additional good factor was it was possible to increase the power of the booster engines. All these effects, but mainly the accuracy in which we had the precise alignment of the velocity vector to go to the moon. This helped to reduce weight on the service module. The weight on the boosters doesn't mean very much because the more you go into the forward stage, the more and more needed to have less weight to operate it in order to bring back a payload or deliver a payload. It could shift operational base to a desirable payload. This is what happened. That way we were then able to have a very clear profile lunar roving vehicle and so far we had always had a new challenge [796?] the total system.

184. Waring You said a little earlier that the first Saturn V flight was sort of the highlight. Can you remember how you felt after that first ? .

185. Haeussermann No I mean the one going to the moon.

186. Waring Oh I see, the Apollo 8. OK.

187. Haeussermann Actually, I said to myself, "Why didn't they get right away to land that? Why did they have the only concern to go around the moon?" Dr. Mueller who had been so energetic had the audacity, he could have asked for that change!

188. Waring That's right. If you're going to all up test the launch vehicle, why not all up test everything else!

189. Haeussermann True. Everything's going up anyway, completely.

190. Waring Why do you think Apollo 8 was such a highlight? Was it because it came so soon after the POGO problems?

191. Haeussermann Right. It proved that the whole system was finally ready to land on the moon.

192. Waring Is there anything else that we haven't talked about? I've got five pages of notes here.

193. Haeussermann Well you might like to come back someday for some more pictures!

194. Waring These are all very helpful. Several neat things for me here. I believe I will follow you suggestion and talk to [817?]. That could be very helpful. I'm just

working on a section of testing this morning. Well thank you very much for your time.

195. Haeussermann Alright, and if there is anything I can help you [tape off 820]