

**INTERVIEW WITH BILL LUCAS #4**  
**INTERVIEWED BY STEPHEN WARING AND ANDREW DUNAR**  
**NOVEMBER 3, 1992**  
**UAH**

Waring 1: . . . the things you were talking about right at the end.

Lucas 2: I'm not sure what it was.

Waring 3: Make sure we get that recorded. Just talk in a general way about some things that you did during your term as Center Director. Could you repeat for us again what you thought your main achievements were as Center Director?

Lucas 4: I think I mentioned, these are probably ones that are not as well known, but from my perspective, and I think the perspective of the few people who understand them would probably be the most significant things. One is one is [?] the diversification of the Center. The Center had been almost exclusively devoted to launch vehicles, engineering, and development. Out of necessity we saw that there wasn't that much business sufficient to challenge our Center as far as large vehicles are concerned. The deliberate attempt that we made, first when I organized and built up the Program Development and then continuing when I was Deputy Center Director and Center Director, the diversification of the programs and the competing and winning to do programs was I think a significant contribution. Essentially all of the programs that the Center is working on today had their genesis back in that period of the '70s. The second thing which is not unrelated to that was, there was a pressure along about 1976 or '7 to reduce the size of NASA. That goes on. It will go on now if we have a new administration, or whether we have a new administration or not it will go on with the cutback in the military. They will go through that now. We went through this period when NASA was having to reduce at one time the total strength of

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NASA was about 31,000 in-house people. That was reduced by about 10,000 people, and a large part of them came out of the Marshall Space Flight Center. Along about, I've forgotten but I think it was around '76 or '77, there was a push within the Agency to see how we could become more efficient and reduce people. One of the thrusts of that consideration was closing the Center perhaps. Marshall was a key Center on the block to be closed. We were able to make a case that we had a unique capability within the Agency. There were some things that we were doing that others could do, but there were some things that we had the capability of doing that no one else in the Agency had. We were able to make a good case and prevent the closing of the Center. We came, in my opinion, dangerously close to being closed. I mentioned the [?33] crew, we set aside a little strategic planning group, and that small group worked without much fanfare and without much publicity. Even to this day, not too many people know about that group's existence.

Waring 5: Who was leading the [?36] to down size the Center? Was it coming from the Ford and Carter administrations with all [?38] people?

Lucas 6: The Carter administration.

Waring 7: When you put together, I assume you put together a presentation and made this to . . . .

Lucas 8: A series of presentations, and we made them to the Agency itself and probably we talked it over in OMB on occasion too. I don't remember in this particular context, but we may have, probably did.

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Dunar 9: I've seen some documents from Washington from that period in which there were discussions and options for different Centers. At that point, did that ever go beyond the Agency or was that simply an internal discussion?

Lucas 10: I suspect it was. I'm almost sure OMB was involved.

Dunar 11: Was there ever a formal resignation for a Center being designated if one were to be closed?

Lucas 12: There were, I don't when you say a formal resignation, the Agency thrust was to reduce all across the area. The only two centers that I know of that were considered for elimination would be the Marshall Space Flight Center and the Lewis Research Center. Those two centers were on the block so to speak to defend themselves against being completely closed.

Dunar 13: Ames too?

Lucas 14: I don't know. It may have been. I wasn't so aware of that outlet. That probably was because there was the competition mission-wise between Ames and Langley so I suppose that Ames was on that block. I think the most serious consideration was given to Lewis and Marshall.

Waring 15: You talked about how, through the process of diversification, Marshall was competing with other Centers for new business and trying to win your projects. Which project do you think was the most difficult to bring to Marshall?

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Lucas 16: I suppose the science projects were the most. Although during the period of the '70s with the power down reduction in size, virtually everything was a competition between the development centers. There had always been a degree of competition between Johnson and Marshall for the assignment of new development projects. Of course, Lewis facing the same kind of situation that Marshall had although it had been characteristically a research Center could see that under the environment that was to be stamped, it would have been to their advantage to compete for the development programs because their research mission had not been enough to avoid their being considered for closing. I think though overall the science programs that we competed for were the more difficult ones because we had less background in that area. In the case of propulsion, there had never been any question about Marshall's capability in the area of propulsion, it's unique capability. Lewis has a lot of experience in propulsion as well, but not from the development standpoint. Goddard Space Flight Center also has a background in propulsion with their launch vehicle, but it was never a development center. They only had a few people, a handful of people in a project office and not in developing. From the standpoint of developing a new rocket system, Marshall stood head and shoulders above everyone else. Then it was a matter of how much of the program one would have. Whether one would have a degree of independence in developing that program or whether you would be subordinate to some other element of the Agency with that development responsibility.

Waring 17: Would there be any one of the science projects that you found other Centers wanted?

Lucas 18: Each of them. Of course the first big project, there were several small ones and I wouldn't consider those, we used some of the hardware left over from the Skylab to do some projects in science that were not competitive, but the HEAO, the High Energy

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Astronomy Observatory was the first one that was highly competitive between Marshall and Goddard. We won that won primarily on the strength of our capabilities as a systems development center rather than our uniqueness in science. Here again, we used the same philosophy that we discussed some in our last meeting that we didn't try to have science capability internally that could do the whole thing. We tried to utilize the academic community and the contracting community to do the actual work. We maintained enough science capability to keep the contractors honest and to make sure that we were getting what we were purchasing.

Dunar 19: The push towards diversification and the threats to close the Center were going on at about the same time.

Lucas 20: The push to diversification anticipated that it was before that. The push to diversification started about the time I was appointed, coincidentally with my appointment as Director of the Program Development Organization. I mentioned this hide-away meeting that we had down at Jekyll Island where we could see the hand writing on the wall that we're coming near the end of the decade of the '60s. We felt pretty good about being able to accomplish the Lunar program at that time and low and behold we had been so consumed with doing that that we didn't have any other business on the books so to speak so program development was organized specifically to get new business for the Center.

Dunar 21: Was it the diversification efforts then do you believe that kept Marshall from closing?

Lucas 22: I think so. I don't think there is any question about that. There certainly was not enough in the shuttle program alone to keep Marshall occupied. When I say there's no

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question, there's no question that Marshall would have been severely crippled if not closed, even if not closed would have been severely crippled without the diversification. One of the things that Marshall has had to fight in the down grading is this comprehensive engineering capability. You can be an expert in propulsion technology and still not have the systems engineering capability. So with every decrease, it became less practical, or it tended towards being less practical, to maintain a comprehensive engineering development capability.

Dunar 23: Was that then what really made the center of competition between Marshall and Johnson in terms who would have that engineering integration capability?

Lucas 24: Engineering integration capability is always a key to who has a responsibility, ultimate responsibility of the system. That's always a key. There only two Centers in the whole Agency that had, or as far as I know now still have, that kind of capability. The Langley Research Center did the Viking program, but one of their problems was that they were essentially a research and didn't have the capability, or the experience I should say for large engineering development. Marshall and Johnson were established with that purpose in mind, but of course Marshall was already that as part of the Army program, and Johnson was set up in Houston for that purpose. Those were the two large development centers.

Dunar 25: And NASA intended to keep them both as such?

Lucas 26: Yes. I think that's not a bad decision. There was some talk over the years that Johnson maybe ought to be an operational center rather than a development center, but I think it was well to have had two development centers. I think with Johnson being a development center improved their capability to do operations, that is operation of

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spacecraft. I think the emphasis at Johnson Center has been somewhat different than at Marshall that they had had more emphasis on the manned aspect of the program. When they were first formed, they were called the Manned Spaceflight until the name was changed to the Johnson Space Center several years later. They started out to be almost exclusively the manned part of it, and Skylab was when Marshall began getting into the manned part of it because Johnson was overloaded and couldn't do all they had to. The integration of experiments in Skylab became Marshall's responsibility as well.

Waring 27: Maybe a couple more general questions along these lines. While you were the Center Director, what do you think was the most difficult development challenge that Marshall faced as a Center?

Lucas 28: All of them were difficult, and it would be hard to say which was most because we didn't have any two that were exactly comparable. The most difficult challenge I guess came beginning with the '70s. I could compare the difficulty of development in the '70s versus the '60s, of course I wasn't Director of the Center during the '60s, but the cost as I had mentioned when we discussed this before, cost was a variable in the '60s. We had the money that we needed and could do the programs that we needed to do. Whatever we needed to do, we could pay for it. That has not been true since the early '70s, as a matter of fact since the end of the '60s that has not been true. One of the reasons that the Lunar Program was discontinued before we used up all our Saturn Vs was a matter of cost. The cost situation impacted the developments during the 70s and the 80s. I would say if you look at, trying to compare apples with apples here, but as far as the Shuttle Program was concerned which came on my watch, the development of the Main Engine was the biggest challenge. That was because it was a more sophisticated, more complicated, more efficient engine than had ever been developed before, and it was developed with less cost than we

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had been accustomed to using and less hardware. We just didn't have enough hardware. For example, the hardware, take the J-2 engine which was a liquid hydrogen engine developed for the Saturn program. The amount of hardware that we had just for the development of the J-2 exceeded the hardware for development and production that we had on the Shuttle Main Engine. We were hardware starved. That was true of the other programs as well. During the decade of the '60s, we developed several units for test, for static test some for flight test, this sort of thing. That was not true of course in the decades of the '70s and beyond. The Shuttle Main Engine hardware was very scarce and the very first main engine that was flown was flown on a manned vehicle. I would say that the Shuttle Main Engine was the largest challenge as far as the development of the shuttle itself is concerned. The next challenge for us would be the Solid Rocket Motor and the challenge there was, of course we had to depend on the contractor largely there because we simply didn't have the depth of capability in solid rocket propulsion that we had in liquid. The Tank was more nearly what we had been accustomed to before. The insulation was something new, but it didn't compare in my opinion challenge-wise with the other two. As far as the science programs were concerned, here again we were strapped for funding. The HEAO had to be redefined during the process of this development, but when all was said and done, HEAO was developed under cost. At the time it was developed, I guess it was the lowest cost per pound of any large payload that NASA had ever developed. The Space Telescope was a bigger challenge than the High Energy Astronomy Observatory because it was a more complicated program in the first place. The interfaces were not at all simple with two Centers involved and without crisp interfaces what we had, that program was very complicated. The lack of funds over the years made it exceedingly difficult.

Waring 29: We will want to come back and talk with you about the [?202] projects. Have you read Robert Smith's book?

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Lucas 30: Who's Robert Smith?

Waring 31: He's an historian with science in the Smithsonian. It's an interesting book. It has a lot to say about Marshall [?206-209].

Lucas 32: [?210]

Waring 33: [?211]

Lucas 34: A lot of these historians who have written have done that not as you're doing it, but on the basis of things they've read. For example, I don't know if he has ever been to Marshall Space Flight Center.

Waring 35: He has.

Lucas 36: I don't know who he talked to. He never talked to me.

Waring 37: It's a good book. I know he talked with Jim Downey about it. I'll send you the reference over to make sure you get it. It tells a lot about Marshall's involvement.

Dunar 38: You mentioned something before about the Carter administration, and from what I've read other officials in the Agency have always been quite critical of Carter's lack of support for the space program. [?222] Could you comment a little bit about what you thought of Carter's leadership and how it related to NASA?

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Lucas 39: Carter had so many problems that I don't think space was high on his agenda. He really didn't stay there long enough to have any lasting impact on the program. The space program was already in decline budget-wise before Carter came on board.

Dunar 40: That's why I'm wondering if this wasn't fully beneath his control.

Lucas 41: I think that's true. I don't think . . . it had started several years before Carter came into the picture. It started with Nixon as a matter of fact. Carter had other agenda items. For example, his administrator that he selected never had the access to him that administrators had before that time had with the President. NASA had been a real plum for the President's before that starting back with Kennedy of course and Lyndon Johnson and so on. Nixon actually started the Space Shuttle, but he became involved in other problems as well as you know. Ford was in only a short time and Carter had other problems.

Dunar 42: Maybe in part the Vice President's opposition or adversarial relationship with NASA? Mondale's opposition? He had been a long-term critic of NASA too.

Lucas 43: That's right. There was just never much floor space at that time. You historians would be far better to address this question than I am. We looked at it from the standpoint that we didn't get very much support out of the Carter administration. I guess I'm sort of prejudiced in that I think Carter was not a good President at all, whereas Harry Truman was viewed in retrospect as a great President. I don't think that will ever happen to Carter because he was preoccupied with too narrow a view. He was what you might call a hands-on person. He didn't trust anybody. He was involved directly in so many things and the job is just bigger than that. There were some people in his administration who were favorable

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to space. They did start the Senior Executive Service which gave recognition to key executives in the space program, and the space program got a pretty good shake-up out of those. Certainly, proportional wise they did well in that regard. It wasn't all bad, but from my perspective, space was not high on Carter's agenda. Maybe a second administration, it might have done different.

Dunar 44: Robert Frosch as Administrator then had his hands tied [266] lack of access?

Lucas 45: Yes I think so. Bob Frosch is a good man, and I still have contact with him. He works for General Motors as Vice President for Research. He's a very bright man. His background in space was not great at the time he came on, and his access to Carter was not great. I just think that he didn't have the kind of influence that people would have liked him to have done in the administration.

Dunar 46: Did he play a role in the issue of possibly closing Marshall?

Lucas 47: Yes, he was the Administrator.

Dunar 48: Was he supported of Marshall or was he distant from that decision?

Lucas 49: I don't know how he felt personally, but it turned out that the Center was not closed during his administration. He, at least openly, tried to save the position that I would have if I would have been in his case. He tried to be impartial and have a study done and see what the results came out to be.

Dunar 50: The Center got a fair shake from him?

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Lucas 51: Yes.

Waring 52: We need to make a change of subject here. I would like to get some comments from you about the Rogers Commission. I've read, both Andy and I have read lots of documents and lots of testimony so there's a lot of information on the record. Primarily I would like to get your response about the Rogers Commission's findings. Please be reassured we understand how sensitive this issue is, and we're not looking for any smoking guns or responsibility or anything like that. As far as I know, in our reading I don't think we've read anything that really gives Marshall's whole reaction to the Commission report. What I'd like to do is maybe ask you general questions, and then go through some of the recommendations and get your response to what the Commission recommended. Maybe first of all just start with a question like in most accidents in NASA's history the investigations have been internal, and this one was done by a Presidential commission. Do you think that was a wise decision?

Lucas 53: This was a clearly a gross error, but it had its basis in that at the time NASA was somewhat disorganized. Jim Beggs who had been the administrator had resigned at the time. I believe he was still probably around Headquarters, but we had a person who was acting administrator named Bill Graham who was inexperienced, had been sent down to be Deputy Administrator over the objection of Beggs, and he really didn't know how to maneuver. So the whole thing because of inaction on the part of NASA became a totally politically motivated commission. Had Beggs been there under different circumstances or any of the other previous administrators of NASA, we would have done what NASA has the practice of doing. That is establish your own committee to investigate on the technical basis of what happened. For example, there is an emergency procedure for the Agency.

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Each Center had an emergency procedure, a catastrophe procedure what happens. For example, we had in being a plan to do if you had a major problem with any element or the hardware we were for. There was already a committee named who would take care of that kind of thing if not by individual named by position. For example, someone who would be Chief Engineer or something would be designated as head of the investigating committee. We activated this several times in the case of the Space Shuttle Main Engine and other things. When we had the fire back in '67, that kind of thing was handled internal, with extra people from the outside the Agency only, but primarily the internal [?330] of the program. That's the way it should have been handled this time, but I think there were several things that impacted it. Perhaps, the principle one was what I just said, the inexperience at the head of NASA and somewhat disorganized. I understand that Mr. Beggs advised Mr. Graham on what to do even to the point of indicating whom he should appoint to such an investigation, but he ignored that and went his own way. It resulted in the establishment of a political committee headed by Mr. Rogers who was of course a politician, a lawyer, and had to my knowledge no real connection with the space program at all. There was another factor that played into it and fueled the political aspects of the investigation. That was that there was a statement made to, as far as I know wrong it was an error, that NASA was anxious to launch on that particular day because the Vice President was going to be there, so there was a tendency to distract anything away from that. I mean not to have that be a factor in it and therefore it was a political thing.

Waring 54: Right. I think the President was planning a state of the union address that night and they wanted . . . that's a good way of looking at it. They wanted to deflect, well not deflect attention, but make sure everything appeared [?354].

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Lucas 55: That's right. That is amplified by the fact that his Chief of Staff was a person who eventually got in trouble with Mrs. Reagan. Donald Reagan who is a political preacher and who I think selected Rogers. He wanted a tough, as he was quoted at the time, wanted a tough district attorney type of person to head this commission. The idea in my view was never to find out technically what went wrong, but to find out where we could put some blame that would deflect it as far from the administration as possible. That's the basis on which we started, and that's the basis on which it ended. I doubt if we ever declared the real technical problem that in my judgment we did not declare the technical problem that we have.

Waring 56: I'm not sure what you mean by that about the . . .

Lucas 57: Well what do you get to be the technical problem?

Waring 58: In my reading of the Rogers commission would be that their analysis was that their was a flaw in the design of the joint and the O-ring seal. Would you say that's . . . ?

Lucas 59: I would say that the joint design was not as good as it should have been and not as good as it is today, but in my opinion the cause was the thing was not assembled correctly. The O-ring was damaged in the assembly process.

Waring 60: Assembly over design?

Lucas 61: The design is not as good as it should have been. We knew that we had some problems with that design. Everybody in the Agency knew it from the Administrator on down. We were in the process of working that problem. Nobody that I know of thought it

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was bad enough to have caused the problem we encountered. Undoubtedly the cold weather had some impact on it, a significant impact, but I believe, although we could never prove that, never got a chance to prove that, but I think that the circumstantially the period back there that the O-ring was damaged in the process of assembly.

Waring 62: The Rogers Commission as you know as you've alluded to here, made lots of judgments about NASA's organization and Marshall's organization, a judgment beyond the technical causes. I'd like to sort of summarize those and get your response. One of the first ones was that NASA managers, NASA Project Managers, felt pressure to launch and maintain the Shuttle as an operational program. Was there an intense pressure to launch to stay on schedule?

Lucas 63: I don't think so. It's hard to discriminate those pressures. In the development of the Program if you've got a schedule you'd always like to make that program, but I don't know of anybody at Marshall who would deliberately knowingly take a chance just for the sake of schedule. We had never done that before. We'd been called down from launches, and I didn't feel any pressure, and I didn't think that there was any pressure. I don't know what pressures might have been felt by someone with regard to the President's speech, but I felt none and I don't believe anybody reporting to me felt any. If it did, it came from somebody else. Not from me.

Waring 64: Right. The Commission found that there was no Presidential pressure. I think what they've meant was just general scheduling.

Lucas 65: There was schedule pressure. There's always schedule pressure. That's true, but I don't believe anyone took a recognized risk in reference to pressure.

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Waring 66: Another judgment of the Rogers Commission was that the launch decision process was flawed. Here they were talking about the flight readiness reviews. Could you comment generally about your feelings about NASA's flight readiness review process. Do you think there were flaws?

Lucas 67: In principle and organization I don't think so. I think the process that was used there was the same process that had been used for twenty years or more in launching vehicles. It's always easy to say if you launch and you have a problem as you did in Challenger, obviously something squeaked by. That's the conclusion from somebody from the outside, and in that sense you'd have to say that "Well, the results say that something was wrong." As far as the, it may be that in its implementation something was wrong, but the process of review I think was not a flaw. I don't think it's changed substantially even now has it?

Waring 68: So a single accident or a single bad judgment doesn't indict the whole process?

Lucas 69: Well, I would say that. I don't know if its a bad judgment. There was obviously some bad judgement, but the process I suppose that all the deliberations that had been going on during the night was never brought to everybody's attention. In that sense, that turned to be bad.

Waring 70: I didn't necessarily mean it was bad judgement, but as you say, there was a decision made, and it was followed by an accident so it's easy to put the blame back on previous decisions.

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Lucas 71: Sure.

Waring 72: Another general organizational judgement that the Commission made was that the NASA had a what they called a Silent Safety Program. We can handle that generally but maybe I should add the more specific complaints that the Rogers Commission had. That was that the problems were not adequately tracked, independently reviewed, and surfaced at a high level of management. Could you comment on that? Did NASA have a Silent Safety Program?

Lucas 73: No, that's not true at all. It wasn't silent. It might not have been as noticed as it should have been. The Safety Program probably was not as strong as it should have been because we didn't have the personnel. We had to cut back on personnel. So from the standpoint of safety, we were probably not, well undoubtedly, not as strong as we should have been. NASA had a Safety Review panel made up of prestigious people from across the country in the industry that reviewed NASA and made recommendations to the administration on the safety of the program. I wouldn't say it was silent. When you have a problem that involves loss of life, you have to say that something is wrong with safety. I think the Safety Program could have been stronger, and I believe is stronger now than it was because they have relaxed their constraints on the numbers of people and so forth, but to say it was silent was an overstatement. The problems in the launch readiness preparation, the process that was allegedly flawed, the safety concerns that came up, or any concern that came up in a previous flight was always addressed and dispositioned before the next flight went about. I think saying it was silent was an overstatement.

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Waring 74: Some of these other judgements are rather more general. Another judgment was that Marshall was isolated and withheld information from the Shuttle Program office at Level II in Headquarters.

Lucas 75: That was made and that's probably one of the most hurtful things because it's the furthest from the truth. The readiness reviews were held in the presence of headquarters and everybody else including the Administrator. As a matter of fact, eventually Larry Mulloy happened to find a tape of the readiness review in which this very thing was discussed.

Waring 76: I'm trying to find that tape.

Lucas 77: I wish you could because the commission really never paid much attention to that which I consider unfortunate because it clearly showed the weakness in that particular design joint had been recognized by Marshall, by Johnson, by Headquarters, including the Administrator. To say that Marshall was isolated in my judgment is not true.

Dunar 78: Was that tape turned into the Rogers Commission.

Lucas 79: Yes.

Waring 80: I think it came out right after the report was published.

Lucas 81: I don't know. It was late in the proceedings when they found it. They'd already made up their minds, but . . . .

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Waring 82: Maybe the recording had already been in press at time.

Lucas 83: I don't know.

Waring 84: I'm pretty sure I'll be able to find it. I'm going to call Mike Wright to see if he's located it for me.

Lucas 85: That kind of thing might be interesting because it clearly shows beyond our statements to the effect or beyond the Program Managers statements, that this had been brought out. The readiness reviews, even the quarterly reviews of the program not associated with the launch were always done in the presence of Headquarters and the Johnson Center. To say that it was isolated is not true.

Waring 86: A related judgement by the Rogers Commission was that Level III, the Project Managers here at Marshall, felt more accountable to the Center than to the Shuttle Program Office. This obviously relates to the chain of command.

Lucas 87: [?540] Marshall Shuttle Program?

Waring 88: To the Johnson, to the Level II office.

Lucas 89: I don't know. We had at Marshall there was a level between the Level III and the Johnson. We had of course a shuttle manager, over all manager of all the elements Marshall was responsible for. He was responsive to Level II. The Level III went through that person. We called the [?550] Level II and 1/2 or something like that. That's the way their reporting was. I don't know whether that's what they had in mind or not.

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Dunar 90: It comes back in a sense to the issue of having two bosses in the interests of management systems.

Lucas 91: No, this wasn't the way of it. Actually we had here at Marshall, the Shuttle Projects Office. Then we had a project office we'll say for the Solid Rocket Motor (SRM), the External Tank, and SSME. These were so called Level IIIs. The Shuttle Project office here was reported to Level II. This person reported to Level II at the Johnson Center except for money which came down from Headquarters up here. In the sense that these peoples reported through that person here officially might have been what they referred to, but I don't think so.

Dunar 92: Then this Level also reported to the Center Director?

Lucas 93: That's right.

Dunar 94: I guess that would be questioned as . . . ?

Lucas 95: That's the way every project was done. Every project was done, since time began. You have a program management organization, OK. You have an institutional manager. The Program Manager is here and he has certain institutional responsibilities, but he also has program responsibilities to the Headquarters and to wherever Level II is and in this case it was at Johnson Center. That's not different than how it had been for twenty years before that.

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Dunar 96: I guess in a sense it comes to defining what are program responsibilities and what are institutional responsibilities. Isn't that a little . . . that could be a little vague. In other words, when there were engineering problems that he quoted to you on the engineering problems as well to JSC . . . .

Lucas 97: The Center had that responsibility to make sure that these engineering problems were being taken care of. If the Program Manager on the solid rocket motor or ET had an engineering problem, he didn't go to Johnson and say "What do I do?" He goes to his own resource over here which is his science and engineering director. So it was the Center, the institution's job to make sure that all the resources that one had were brought to bear on the program. The matrix management thing is where we have the science and engineering directors over here. Then there was a Chief Engineer who reported to a Project Office, but he also had access to the laboratories where the technical capability resides. I think that's good. Marshall has more engineering capability than any of the other Centers, than Johnson, in-house. This was never a problem to my knowledge until this accident and the Rogers Commission. There was good interface, day to day interface, not only between this level but down in the working [turn tape over 619].

Waring 98: I think part of it was that judgement was based on the notion that the Level III managers at Marshall in the final flight readiness review should have made the report to Level II. The broader issue was the Level II manager well informed about the [?623] case.

Lucas 99: [?624] case.

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Waring 100: The reason I think the Rogers Commission thought the [?624] case was important was that Marshall projects were moving ahead in effect on a new design, as a capture feature on the joint.

Lucas 101: That wasn't the [?626] case though. The [?626] case was part of the program but there was also another design for the steel case.

Waring 102: I see.

Lucas 103: That was well known too. That was not done in the dungeon. You had to get money for those kind of things. You don't just get money by calling up and saying "Send me down a few billions."

Waring 104: So if Johnson people said that they were not aware, would you say this is . . . well what would you say something?

Lucas 105: I guess I would have to say that maybe the individual who made such a statement was not aware of it. I couldn't say that he was misrepresenting. I don't now that. I would say that the program office at Johnson Center was aware of it. I would assume many other people, and I don't know who made that comment, but he might have been asleep or something. I don't know. There was nothing to my knowledge going on in the program that was not common knowledge throughout the program. The only thing I know of that was not common knowledge was the description of what occurred the night before, the so-called very hard arguments about whether we're ready to fly or not and the apparent fact that the management of Thiokol applied pressure to their engineering people. That

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was not known generally. It was not known to me either. I don't know if it was known to our Level II or III 1/2 or whatever you call it manager or not, but that not known.

Waring 106: I don't think it was ever made clear to the Marshall people during the review that there were Thiokol management people in the meeting.

Lucas 107: No. It wasn't made known to me until after the fact, as a matter of fact well into the investigation before I ever knew that. I think the same was true with the next level of management, the Program Manager over here that reports to me. I suppose he didn't know either.

Waring 108: Another judgement, and this is the final judgment I think from the Rogers commission was that there was one understanding of the joint and the O-rings at the level of the working engineers. Then there was a different level of understanding about the joint and the O-rings from the Project Manager and that there were barriers to communication between working level engineers in the labs and the project managers. Could you comment about that?

Lucas 109: I don't know about that. It's always, when you've been around as long as I have, you see that after an accident has occurred or after any problem had occurred people sometimes say things that they didn't say beforehand. If people had given the opportunity to make those comments and don't do that, then there's not anything you can do about that in the rears. You can do something about it in the future. On all the reviews, all the project reviews, the periodic project reviews, as well as the flight readiness reviews, the working level people were always involved in the meeting and were asked and expected to speak up and make known any reservations whatever they had. I can't question whether they

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were intimidated or not. To my knowledge, they were not because they were in the meetings and were asked specifically to speak up. There was also a practice within the Center where the working level people could communicate directly with the Center Director in the Weekly Notes. There were plenty elements, and we also had [?670] to take inputs from anybody within the Center and then he would work those problems with me or with whomever without even identifying the name of the person having the problem.

Waring 110: Was that an institutional [?673] or was that part of the safety office?

Lucas 111: It was institutional. As far as people not communicating, there are undoubtedly as is in any organization of that size, there might be some people that do communicate, but that was not a matter of organization, a matter of practice, or a matter of expectation. That's one of the things that the Center always prided itself on. It's what we called automatic responsibility. The laboratories have automatic responsibility for the technical integrity of the hardware.

Dunar 112: Was the [?680] office used frequently for technical issues or was that mostly for personnel?

Lucas 113: It was used for both. I wouldn't know who they were, so I wouldn't know . . . .

Dunar 114: But this sort of issues that came forward through that office were a balance . . .  
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Lucas 115: Usually they were personnel matters, but they were also engineering matters.

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Waring 116: Now I have several interpretations that have come from engineering articles and management articles on the disaster. Maybe we can start with an idea that Chris Kraft gave to us. He felt that Beggs as an administrator tended to use very heavy-handed practices and that he had created what Kraft called an underground decision making system. Centers tried to solve their own problems. Do you think that was the case? Do you think Beggs, for instance Beggs was never called before the Rogers Commission and never gave testimony on the issue, perhaps . . . . Anyway, do you think NASA Headquarters and NASA Administration, how would you assess their role in the large sense?

Lucas 117: In what? In the accident?

Waring 118: In the accident or in the background of the shuttle flights, schedule, pressure to launch, or anything like that?

Dunar 119: The point we're getting at is that information simply wasn't coming forward in the Agency on many different matters because it would be better for the Centers to handle their own problems rather than bring anything forward because of the system that things created.

Lucas 120: I don't know. I haven't given a lot of thought to that. I would agree with Chris that Beggs was a heavy-handed manager. I certainly agree with that. I can say that the Headquarters Administration was informed and a party to the program. I mean program considerations, program concerns, problems, and resolutions. To say that they were not, just won't jive with the facts. They, as a matter of fact I thought at times they were too much involved in some of the nitty-gritties because they couldn't possibly understand all the

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details because they didn't have enough time to do that and didn't have the right kind of people, but they were there. I think Headquarters was well informed of program considerations and concerns, but I think the management scheme that was established for the shuttle was not good. It was conducive to the kinds of things, some of the things that you've mentioned here that came from the Rogers Committee. You didn't have the clean interfaces that we had in the Apollo program. In the Apollo program, you had clean interface here. Below this point, Marshall was responsible. Above this point, Johnson was responsible, and there was at Headquarters Program Office in Washington, overall responsible. I think the situation management-wise and Headquarters really didn't have the engineering talent at Headquarters to be an effective Level I. I think it would have been more effective, a better organizational scheme to have made Johnson Level I for that matter. Then you wouldn't have the ambiguity that apparently confused people.

Dunar 121: The problems in management then that you are describing in the shuttle management were at Headquarters or where there other problems . . . ?

Lucas 122: What I'm talking about is just the split. You've mentioned yourself on the one hand the technical Level II was in Johnson. The resources, the funds came from Washington direct. There's an old axiom, the so-called golden rule in project management. He who has the gold rules. If you maintain fiscal resource control, you control the program. What you would do is make, I don't say that they did that, that they made fiscal decisions without advantage of technical knowledge, but they didn't have the basis within their own house of getting that knowledge. They had to get it someone from else.

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Waring 123: I think one of the reforms afterwards was to try and make the organization more similar to the Apollo style of organization. I don't know quite how effective that has been, but . . . .

Lucas 124: I don't know either, but that would have been the thing to have done. We knew that to be the thing to do in the first place. I don't know whether Chris thought it was a good idea to start with or not. I certainly never thought the management arraignment doing the Shuttle was ideal.

Dunar 125: They did raise a lot of objections in the early program [?748].

Lucas 126: Yes, and I think they were right in doing so.

Waring 127: Another line of interpretation that is prominent in management journals is that the people involved in the decision making in the NASA organization were engineers who perhaps were not as well trained at general management skills, running meetings. Could you comment on that?

Lucas 128: So many of these things that you bring out and that were covered in the Rogers report are things that one could have written without having made any investigation at all. Wouldn't you have immediately concluded that if you knew here was an organization made up largely of engineers and they had a problem. If I were a manager, if I'm in some management organization, I'd say "Hey, they didn't have enough managers. These guys don't know how to manage." That's just generalizations that have little relationship to the actual situation. Now coming back after having preached that little thing, let me just say that I don't know that there may be some fact to that, but we had some managers in

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Headquarters that didn't have technical knowledge of the project. If that's what you want, putting more of that I don't believe would have helped any.

Waring 129: Right. NASA had been running technical programs with engineers acting as managers for twenty years.

Lucas 130: For twenty-five years NASA had been doing that. It's true that people with purely technical training don't have some of the nuances of professional managers, but they do just not suddenly become managers. They grow up through the system. They learn by doing and by watching others do, and many of the engineers that were in management positions had also been trained in Sloan fellowships and this kind of thing to do their jobs. I don't think that statement has narrowed at all. There are some schools of management that believe that the manager can manage anything. That's never been the philosophy of NASA. NASA, being a highly technical organization, has had the philosophy that you can manage better if you have some knowledge of what you're trying to manage. For the most part you'll see, with very few exceptions, as a matter of fact I can't think of one right now, where there's been a Center Director who didn't come from an engineering and science discipline. Most of the administrators have come from those. The best one we ever had, however, did not. That was Jim Webb. He was a lawyer, but most of the others have had engineering or science degrees. It really comes down to the individual. I wouldn't give much credibility to that kind of statement.

Waring 131: This is the [?788] last question and then we can talk in a few more general terms if there's things you think we haven't covered. Another interpretation that comes out often in scholarship, or sometimes comes out, is that Morton Thiokol had some sever

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internal management problems that did not become clear until after the accident. Did you have a feeling at the time that Morton was a well-run organization?

Lucas 132: No. I really never thought of Morton Thiokol as being our strongest organization. There were obviously problems management-wise in Morton Thiokol that didn't come out until after. Certainly I didn't know about them. On the other hand, Morton Thiokol was fairly new to NASA as an organization. We had worked with the Martin company. We had worked with Rockwell, Rocketdyne, and all those. They were pretty well esteemed in the NASA tradition. Thiokol, on the other hand, had been largely an Air Force contractor, and they managed differently than Marshall or than NASA does. NASA has always had more technical penetration into the contractor than the Air Force has had. Here again, I think you couldn't avoid the kind of statement that you've just read there. When you see that coming out of the woodwork after the fact that there were technical people who felt very strongly about certain things and that they were either ignored or put down by the management, that's a problem. You just don't do that kind of thing in the NASA programs. We've always encouraged, I think one of the problems that has been generated for NASA by the Rogers Commission is that it works to the disadvantage of the tradition of NASA and that is that the lowest person on the totem pole could rise up and say, "Hey, let's not go. We've got a problem here." You want to surface this problem and don't go. The implication that that's not done or the public thrashing that NASA got from the Rogers Commission is certainly in my judgment detrimental to the kind of program that NASA has the reputation of running.

Waring 133: The purpose of the Rogers Commission they said was to try and open up NASA and could be counterproductive.

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Lucas 134: I think it could close up NASA. I think it's counterproductive entirely. I didn't have the sense that a fair assessment was actually the aim. As I said, I think the reason was to assess blame and get it out of the way as quickly as possible.

Waring 135: Why do you think they had that? Was it because they didn't have enough experienced technical people? Was because it was an open public committee with too many lawyers on the commission?

Lucas 136: I don't want to say anything about on lawyers too bad.

Waring 137: Don't worry. I will.

Lucas 138: That's an honorable profession in my judgement. I think as we discussed earlier in our conversation, the way the thing was formed in the first place. If it had been formed by NASA, I think you would have gotten a resolution with a program internal to NASA. NASA would have strengthened itself. There's nothing that I know of that the Rogers Committee found justifiably that can be defended that NASA wouldn't have found. I just think that it was a very bad way for it to have been done, and its genesis almost determined its outcome.

Dunar 139: Could you elaborate a little bit more, you said just a couple of minutes ago that the recommendations of the Rogers Commission instead of opening NASA had the effect of closing if even more. Could you elaborate on that or did I misunderstand?

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Lucas 140: No. I think that what it amounts to is that it would make people more inclined to protect their own tail so to speak rather than have a purely open situation that it might even close down that kind of thing.

Dunar 141: Through requiring more reports and so forth?

Lucas 142: Right. For example, this is not a factual statement I don't know this to be a fact, but as far as what I have been told NASA, because of the Rogers Commission report, has build up a tremendous [?856] of people to launch one of these vehicles. They'd like to back off, but they don't know how. If you've got paper on top of paper and people on top of people and can price themselves right out of the market. The Challenger accident was a very traumatic thing for all of us who were involved with it and will always be. Even the recollection and memory of it is difficult. On the other hand, you have to recognize if you are going to stay in this business, you may have another one of those things. With the millions of things that can go wrong, the odds are that one of them is going to go wrong again sometime. In a high risk business that NASA is in, the only way that you can preclude a flight problem is not fly.

Waring 143: The purpose of NASA is to fly.

Lucas 144: To fly and to push new frontiers. Back in the early days of rocketry in which I was involved in this country, we had a lot accidents, explosions on pads. It didn't involve people, but we had a lot of accidents, a lot of problems. That was not because of people were incompetent because they had a bad organization, because they didn't have communication, because they didn't have all these other things that the Rogers Committee came out with. It's because we were pushing the state of the art, and we had a problem.

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You're going to have problems. That doesn't say that you're not going to do everything possible to avoid problems. I think one should, but I think you have to be prepared in the normal course of advanced development to have accidents. They're going to happen. That's been the history of technology has it not. I mean I should know about history, and it's your field, if you looked in the history of technology, you'd know a lot of that has happened.

Waring 145: Should we hold off on Spacelab?

Dunar 146: We had some questions on Spacelab but I think it's kind of late to begin another topic.

Lucas 147: I'm sorry.

Dunar 148: That's OK. If you don't mind, maybe we could get one more before the end of the year on Spacelab. Thank you very much.

Lucas 149: Spacelab's a very interesting national program. To have managed that program involving ten different nations without financial control, I don't think you could do it with all these problems in management over there.

Dunar 150: The complexity of it is just magnified by [?897] nations involved. [stop tape 898]