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ALLAN R. KLUMPP
INTERVIEWED BY SANDRA JOHNSON
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JOHNSON: Today is May 10, 2018. This is the second interview with Allan Klumpp, and it's being conducted in Philadelphia, Pennsylvania for the NASA Headquarters Oral History Project. Interviewer is Sandra Johnson, assisted by Jennifer Ross-Nazzal. I want to thank you again for letting us come back and talk to you some more.

Yesterday we were talking about mainly the early Apollo missions up through Apollo 11. One of the things I thought of is I know there were different languages that were being used to program the guidance and the navigation. Were those languages for the LM [lunar module] and the CM [command module]—were those languages created by MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts]? Or were they modified from something else?

KLUMPP: They were.

JOHNSON: Okay, they were created?

KLUMPP: Yes, they were.

JOHNSON: Was there a team of people working on that, or was that part of what you and Don [Donald] Eyles were doing?

KLUMPP: Don Eyles and I, neither of us had anything to do with the language. The language already existed when I first came to the [MIT Charles Stark] Draper Laboratory. One of the initial questions that I was asked was, "Do you know how to program?" I said, "Yes, I learned programming in FORTRAN [Formula Translation]." The instant response was, "Well, you wouldn't believe how much better MAC is than FORTRAN."

I thought that was part of the "not invented here" thing. But I found out very soon that MAC actually had preceded FORTRAN, and the direction in which the adaptation of one language by another went was that after MAC was introduced, people came to look at MAC and that's how FORTRAN came about. It went in the other direction, from MAC to FORTRAN. MAC was first.

It really was a language which made it possible to write things much faster than you could do it in FORTRAN because of the vector and matrix operations that were part of MAC. It was an algebraic compiler, it was called. That's what the word MAC came from, MIT Algebraic Compiler. It didn't take long to acknowledge that MAC was a lot better than FORTRAN for our purposes, because most of what we had to do was in vectors and matrices, and there was no easy way to do that in FORTRAN.

MAC made it just automatic with its three-line format. Above the main line was either the dash indicating that what was in the main line was a vector, or an asterisk meaning that it was a matrix. If it wasn't anything, if there was nothing in the line above the main line, then it was just a value, and neither a matrix nor a vector. All of that was automatic, and once you got used to reading it, which wasn't hard, it was vastly superior.

JOHNSON: That's interesting, especially since it came first. I guess it was easier for what you needed to create those programs.

KLUMPP: What we needed. The IBM people came and developed FORTRAN from MAC really more than the other way around.

JOHNSON: I assume FORTRAN could be adapted for other things, and maybe it was not as good for spaceflight.

KLUMPP: Yes. Then much later, in the 1990s, FORTRAN did become an algebraic language, too. But it took an awful long time.

JOHNSON: I was reading an article by Don Eyles. He's written a lot, so I was looking over some of it, and he mentioned in an article that your boss, George [W.] Cherry, once said that—this is the quote, "The perfect is the enemy of the good." He said that George Cherry thought that software designers were considered the prima donnas by NASA because they couldn't—and this is another quote, "quit fiddling and let the product out of the door."

How did you balance that? I would think there was a perfectionist component to what you were doing. You were trying to make things work as well, because it was a matter of life and death with the astronauts and with the hardware. How did you balance that safety aspect with the push to hurry up and get Apollo going and get things going and get it done? Was that ever a problem?

KLUMPP: I don't think that was ever a problem. We just had to be sure that everything that we did was going to work.

JOHNSON: You did that with simulations?

KLUMPP: Yes, we did.

JOHNSON: How much time did you spend doing simulations and correcting the code and the programs? Was it a lot?

KLUMPP: Very, very much. We simulated everything so there could be no doubt that we had tested everything and made sure that nothing was going to blow up. It was only violating the rules of the game—like allowing the astronauts to say that we're going to start the abort guidance before it was supposed to be started—that caused things to blow up. Because that was a violation of the rules, and it sure blew up.

JOHNSON: Where did you do the simulations? Was that at MIT, or did you go to different [NASA] Centers?

KLUMPP: Other Centers could use our code and work, too. In fact, they did. Even in Florida [NASA Kennedy Space Center] they would. Anybody could use the MAC language and do simulations, too. In fact, late in the mission I found out that they had already invented something in Florida that we had then reinvented later, not knowing that they had already done it.

JOHNSON: It was just the program?

KLUMPP: Yes.

JOHNSON: Did you go to the other Centers for the simulations when they were running, or at any point?

KLUMPP: I certainly went to Florida quite a few times. I don't remember all the reasons why I did, but I certainly did do that a lot of times.

JOHNSON: Let's talk about Apollo 12, because that was an exciting launch because of the lightning strike.

KLUMPP: That's right, it was.

JOHNSON: What are your memories of that?

KLUMPP: Pete [Charles] Conrad [Jr.] had made it perfectly clear that he was a fast thinker, and he really saved the mission.

JOHNSON: What did he do that saved it?

KLUMPP: He practically instantly said, "This light is yellow, this light is blue, this light—" He just went through the entire picture of what was being warned about, and there's no doubt in my mind that he was expecting the rocket to do this [demonstrates crashing], and that they would want to know why.

But it didn't, and the reason why it didn't was that the lunar module was on top of the Saturn V rocket below it. Its being on top, that's where the lightning struck. But the Saturn V rocket, the computer that was running that was halfway down in the waist of it, and was far enough away from where the lightning strike had happened that it was not stopped at all. It just lifted off normally.

So it turned out that there was no real problem, it went normally into Earth orbit. The possibility that there would sometime be a need to realign everything in the lunar module had been anticipated years before, and so there was a scanning telescope and a sextant in the lunar module which could be used to reset everything in case of such a disaster happening. So everything was just reset in Earth orbit, and everything on the guidance computer resumed working normally despite having the lightning strike, and they were off to the Moon.

JOHNSON: Were you listening the same way you were on Apollo 11 at MIT for that one?

KLUMPP: Yes.

JOHNSON: I imagine that gave people a few palpitations when that happened though.

KLUMPP: Yes, it sure did. But it went to the Moon perfectly normally. I haven't told you what the purpose of the Apollo 12 mission was. One of the purposes of the Apollo 12 mission was to recover an instrument that had been landed on the Moon several years before. I don't remember exactly what the instrument was, but I know there was a camera on it.

The camera had been sterilized because we didn't want to have diseases from Earth infecting any living things that were on the Moon or other planets. There were two main purposes for the Surveyor [3] mission which had been flown to the Moon [1967].

[First] to be sure that it didn't just blow soft sand away from it and sink into the ground and disappear. Because we wanted to prove that it was possible to land a spacecraft on the Moon, despite the fact that it had to have a rocket that enabled it to set down slowly on the Moon. We wanted to be sure that it didn't just disappear into the hole that it created by blowing the dust away from it.

The second purpose was to be sure that it was possible to sterilize instruments so that they didn't infect other species on other planets. It was supposed to be recovered and brought back to Earth so that it could be tested to be sure that there was no organisms in the camera.

Apollo 12 was going to land close to the Surveyor. The first thought was that there's no way our landing accuracy is going to be so good that we actually have to displace the intended landing place from where the Surveyor was. That proved to be wrong, too. All the things really proved to be wrong. The way they knew where the Surveyor was was they had the Surveyor camera take pictures of landmarks around itself.

The camera was instrumented so that you knew which direction it was pointing relative to the Surveyor spacecraft, and it took pictures of landmarks at a distance that these landmarks could be seen both from the Earth by telescope, and from the Surveyor by the direction that the

camera was pointed. That's how they'd take this line and this line, and that's where the Surveyor has to be, at the intersection of the lines.

When they actually came down, 12 came down, it was targeted right for the Surveyor. It wasn't targeted somewhere else, because "No need targeting it somewhere else. Landing accuracy is not going to be that good that it's going to have to change its trajectory in order to land somewhere else instead of on the Surveyor." But that turned out to be wrong too, because when they got there and saw the Surveyor, they knew that if they didn't do anything they were going to land on the Surveyor.

So they did redesignate the landing site and landed somewhat off the Surveyor, so they didn't wreck the Surveyor in landing.

JOHNSON: So it was a lot more accurate than they realized it was going to be.

KLUMPP: Yes, that's right, it was. They took the camera off and brought it back to Earth. It was examined on the Earth, and they found that it did have still—there had been organisms on the Surveyor which had survived for the years between when the Surveyor landed and when it was recovered—so the sterilization proved to be not working also. So there might have been a few things there that you didn't know about.

JOHNSON: I was reading in some of the things that you'd written down that your daughter sent, and one of them was about the LM descent erratic throttling that was discovered I think after Apollo 12. Was that when you and Don Eyles were working on that, that there was a throttling problem before Apollo 11? Don Eyles had allowed a tolerance that you thought wasn't enough,

but you decided to let his decision stand and you would worry about it later, because he needed to figure it out for himself that he needed to be closer. Do you remember that incident? I thought it was an interesting way of handling things, because as a mentor for him you were letting him figure out anything that he needed to do, or if he was making a mistake or not, but at the same time if you had made him change it then we may not have been able to land on on the Moon on Apollo 11.

KLUMPP: I'm not sure exactly.

JOHNSON: What we might do is when we're through with the interviews, and if you're okay with it, we'll include your written information that your daughter gave us, because they're pretty interesting stories.

KLUMPP: Yes, okay.

JOHNSON: I think it says a lot about your mentorship and the way you worked with people.

KLUMPP: I always tried to give people credit for the ideas that they had, and always take the best ideas no matter who thought of them.

JOHNSON: Yes, I thought it was a pretty interesting story about how it happened and the way it was handled.

Also, we talked about yesterday on Apollo 13 you had gone back and talked to Jim [James A.] Lovell [Jr.]. Then the coding change that you wanted to make, they went ahead and put it in for 13 instead of waiting for 14.

KLUMPP: Yes, and I think I did mention yesterday that about 10:00 in the morning—when I'd hung up with Lovell at 7:00, about 10:00, my boss came into my office and said, "Your political *savoir faire* has reached a new low."

JOHNSON: After you coded the change and there was a meeting at JSC where it was accepted to go ahead, you also—and maybe you remember this—you described in something you'd written that you said to Bill [H. Wilson] Tindall [Jr.] that "dropping guidance commands sure is a kludge." What did you mean by that, or what is a kludge? If you can explain to us what that is, as far as what you were concerned with. Is it something that ends up working even though it may not be something you expect to work?

KLUMPP: It's something that you shouldn't have to do, that's the meaning that I had. But I don't remember exactly what the details were there.

JOHNSON: I know from what you'd written that Bill Tindall was a little surprised that you had said that to him. He wasn't sure that he was okay with that. You talked about working with him yesterday and how much respect you had for him. I thought it was an interesting story, too. We can try to include that in there.

KLUMPP: "Tindallgrams" [Tindall's memoranda] are well known today.

JOHNSON: Yes, they are.

KLUMPP: Because his thinking was so clear and so fair.

JOHNSON: We've been talking about some of the programming. You were talking about how IBM had come in and looked at the MAC language and then they created FORTRAN. But when you were actually using these languages to create a program, if there was a problem, sometimes was it easier to do a workaround and other times maybe to just redo everything? Did you make those kinds of decisions often when you were working on those programs? Or were there instances where one person wanted to do a workaround and somebody else wanted to start from scratch and redo it?

KLUMPP: There were a lot of times where people did pick among multiple different approaches to things. It was very common for different people to have different ideas about how things should work. I think that most people had the same kind of ideas that I did, that you should always use the best no matter who thought of it. I think that generally people were pretty honest about how things should be done and would discuss it. There were not very many fights.

JOHNSON: So it was easy to discuss with each other and get through it?

KLUMPP: Yes.

JOHNSON: Your daughter mentioned a story that you had told her—this was after Apollo—that you were asked to rewrite a system from scratch, but you recommended that the existing system be modified instead. This was when you were already at [NASA] JPL [Jet Propulsion Laboratory, Pasadena, California]. JPL took a team and they asked them to do the rewrite while you went ahead and did the modification or the revamping of it.

KLUMPP: Yes. There had been I think it was nine different people who had developed most of the software that was necessary for the Spirit and Opportunity [Mars Exploration Rovers] to be landed on Mars. The question was whether it was reasonable to simply adopt what the group of nine people had done in nine years or to start from scratch, because there were so many things wrong with that code that the only way that you could really make it work right was to start from scratch. There was so much code that would have to start from scratch. There was only three years left to do it, three years left before we were going to be landing Spirit and Opportunity on Mars. At that point they hadn't really been named either, but the two missions on Mars were funded, but they weren't named at that point.

I studied the code that was there and found that it was fairly close to what we were going to need. Starting from scratch, my feeling was that they would never finish it in time if they started it and threw all that code away because it was too far from perfect. I concluded that the code that people had developed for those nine prior missions was fairly close to what we needed, and if you started from scratch there was no way that you were going to finish that in time. Especially not just one person doing it.

The middle management at JPL had first thought that they could do it in time, and so they appointed a team of—I don't know how many people were on it. I don't know who was on the team or exactly how many, but it was something like six people started. They formed a team of six people to start from scratch. They told me, "If you think you can do this in time, you do it."

I didn't even know that they had made another team until later, but after a couple years I was so far ahead of the other team that they abandoned the other team and had me just finish it. So I was successful in finishing it on time, working with Phil [Philip G. Felleman], the person that was so sharp at code himself. He was teaching me a lot as I was going along, was amazing how much he knew about this and how perfect he wanted everything to be.

He wanted everything that got written by the code that I was developing to be exactly in the right places on the page, whatever page it would make. He was figuring out just exactly what it should look like, each page by page, because he was thinking that he was going to have to run this code hundreds of times—thousands of times it turned out—and he wanted to know exactly where on the page everything was going to be fit. If I got it off by one space he would tell me, "That's one space too far to the right or left."

He was very exacting about it, and also knew an awful lot about the physics and dynamics of the landing. So I learned a lot from him, even though he was much younger than me.

JOHNSON: You were at MIT through the beginning of when they were first starting to work on the [Space] Shuttle guidance, then you left and you went to JPL. Why did you end up going to JPL again around the time of Shuttle?

KLUMPP: I had already made my contribution to the Shuttle, and I don't think I described in detail what had happened on the Shuttle.

JOHNSON: Okay, let's talk about that. That was while you were still with MIT?

KLUMPP: Yes, I was. One day my boss there at MIT told me that there had been three groups of people, mostly at [NASA] Johnson [Space Center], who were working on developing an ascent steering system for the Shuttle. But he knew that I had already developed one ascent steering system for other purposes. He said, "They're having a meeting next Tuesday and Wednesday." This was on a Friday.

He handed me three descriptions of what the three teams at JSC were proposing to do and he said, "I'd like to have you read this over and attend the meeting and make your comments about these three things, and prepare your own ideas about how it should work." The meetings were going to be on Tuesday and Wednesday of the next week, and so I didn't have much time to do it, but I did make my own sketch about what I thought could be done. They were not too far different from what the other teams had done, but they were different in some basic ideas I had that it could be substantially improved.

The meetings were on Tuesday and Wednesday, and the three other teams presented their ideas on Tuesday morning. Tuesday afternoon I was told to say how I would do it, and I did that. Then on Wednesday we went over the four ideas a second time, and Wednesday afternoon they took a vote on which idea should be used, and they voted for mine. So that was kind of a triumph. But I didn't even vote.

JOHNSON: You didn't vote for yourself?

KLUMPP: I didn't say anything more on Wednesday afternoon.

JOHNSON: How long did you work on that?

KLUMPP: The concept had been adopted, and I knew that I was not going to be in Cambridge very long, because I had already decided years before that I was never going to work on another weapon system program, knowing what the slaughter was of Vietnamese. They were really slaughtered by American airplanes.

So I knew that I wasn't going to be there very long, so I wrote up in the last days there a description in enough detail so that the leader of the team at MIT, could complete all the details. So I did write the preliminary design for it. This was just a preliminary design, Al Engel led a team that completed the design. That's what was used for Shuttle ascent steering.

JOHNSON: Was MIT starting to do more military work at that time? Is that why you decided to leave then?

KLUMPP: What I was told was that there's not too much chance that we're going to get another program like Apollo, that's probably not going to happen. But the lab was going to move to a different building. I was shown where my office would be. I didn't say anything about it because I knew I wasn't going to be there.

JOHNSON: So the opportunity opened up at JPL to go back there?

KLUMPP: Yes, it did. I got an offer to return to JPL, so I did that, and worked on a whole lot more unmanned missions to the planets.

JOHNSON: Was that mainly what you focused on once you got back, the unmanned or the robotic?

KLUMPP: Yes, the robotic missions to Venus, Earth, Mars, Jupiter, and Saturn. Actually I had done the work on the Venus mission before I ever went to NASA Headquarters [Washington, DC].

JOHNSON: Right, you had mentioned that.

KLUMPP: That did fly, and it did work.

JOHNSON: Let's talk about some of those robotic missions. I was reading about some of your work. You worked with Galileo and then the TOPEX [Ocean Topography Experiment]/Poseidon mission and the Mars Rover Sample Return. Those were all very high-profile robotic missions. Were you working on the guidance systems again?

KLUMPP: It was a sequence of a whole lot of different missions that I was asked to do things on.

JOHNSON: Was it similar work for each one?

KLUMPP: No. There were so many missions. You're really looking for what happened in connection with Johnson.

JOHNSON: Not really. We're looking for what your work was. It doesn't have to connect to Johnson, we're doing this for Headquarters. This interview is for whatever you did, but I'm interested in the work that you did there.

I think the robotic missions are so important, and a lot of people, when they think of NASA they think of human spaceflight. But people outside of NASA sometimes forget that these robotic missions have been going on for years and have accomplished great things. Part of that is because of the programming and the languages that you used, and the programs that you used, and people like you to guide those robotic missions. So I think it's important to remember that. Do you have any memories of any of those missions that really stand out, of something that you were really proud of, or something that you felt like was a real accomplishment?

KLUMPP: Yes. There was one thing that I don't think that you knew about. That is the Space Station. It had been decided that the Space Station should use the safest and most reliable language for its basic software. Just as Apollo had used the MAC language—and the MAC language had a lot of features in it which should be available for any programming that was done for the Space Station—and NASA didn't know how they were going to get the software to handle the Space Station's needs.

I sent a message proposing to develop the basic capabilities that were in MAC and perhaps a few others, and that proposal was accepted. So I did write the routines for them, and it was accepted. That was pretty much what was used for the Space Station. Except that some of the routines that I had developed for it were later improved by people who were closer to the Space Station than I ever was. So most of it was used as is, but there were some of the routines that I developed that were later improved. A copy of the software, one copy of the group of about four or five different volumes for that, are still in the house that I still own. I think most of those, they're about five folders that are there. Those were essentially what was done, except that some of the routines were later improved.

JOHNSON: You were talking about the Spirit and Opportunity, and then some of these other robotic missions. Was there a difference for you between working on human missions versus robotic missions in the way you did your work? I know whatever you did was so that the mission wouldn't fail and you wanted the best. But a lot of what you worked on, like Spirit and Opportunity, I believe you actually ended up retiring before they landed on Mars.

So those robotic missions, many of them, what you were working on, they don't get to their destination for another 5 or 10 years. I think that's interesting because some of the programming languages, some of the technology that's being used when you first are working on a mission like Galileo or these other missions—technology keeps getting faster and faster, but these robotic missions are going on with older technology. But it's still working, it's still capable.

Did you ever worry about that when you were creating these languages? That something else was going to be better, but you had to use what you were using, even though 10 years from

now when the craft might arrive at its destination you knew that there would be better things to use?

KLUMPP: Not really. The JPL middle management always chose the languages that things were going to be programmed in. So all in all I had programmed—and by the time everything was done I had programmed in like the six different languages.

JOHNSON: That's interesting, six different ones.

KLUMPP: Yes, something like six. It was about six. But there was just no question about what language was the best language. It was ADA.

JOHNSON: Is that what you used when you were at JPL the most?

KLUMPP: No, because I can't account for bad decisions. I think middle management at JPL was not as good as the management at the Draper Lab. Management of the Draper Laboratory was superb, and that's not true of the middle management at JPL.

JOHNSON: You didn't work on that. Do you remember when Spirit and Opportunity landed on Mars? Were you in the control room, or were you already retired at that point?

KLUMPP: Yes, I did not see it actually. We had already left California on our way to Massachusetts to find a place to live.

JOHNSON: Looking back over your career—and it was 44 years—is there anything that you can think of that you think might have been your greatest challenge that you worked on? Or the thing that you're most proud of that you accomplished?

KLUMPP: The answer to that is, I'd have to say that it was organizing to take a group of people, all men, to march in the march against the wars in Washington [DC], and to help to alleviate the prejudice against the blacks.

When I was at NASA Headquarters in Washington and we lived in Falls Church, Virginia, lots of times we were going to eat dinner out, and we'd go to some restaurant and there would be a sign on the door, "Blacks need not apply," or whatever. That they weren't going to feed the blacks. I would always go in and ask to speak to the manager, and I don't think that that ever failed. I always told the manager, "When that sign on your door is gone we'll eat here, but not now."

JOHNSON: That's commendable. Not many people would do that, would take that upon themselves to stand up for other people like that, that's wonderful. I would be proud of that, too. You definitely need to be proud of that.

KLUMPP: I think that the smartest thing—I've been saying that for a long time—that our government ever did was make MLK [Martin Luther King, Jr.] a national holiday. Of all the things that would relieve hardships between people, MLK's national holiday would be the best.

JOHNSON: Right. Yes, it was an interesting time. You were at NASA Headquarters, yes, early ’60s. Things were starting to get pretty turbulent with the ’60s and everything starting to get a little more active. You were there early on doing things that a lot of people hadn’t started doing. That’s wonderful. It’s definitely commendable.

Is there anything that we haven’t talked about, as far as your career, that you’d like to mention before we go? Or anything that stands out in your mind that you wanted to talk about? It’s okay if there’s not.

KLUMPP: I think with you here I’ve had a great opportunity, so I appreciate it.

JOHNSON: It sounds like you had a wonderful career, and a career that allowed you to touch a lot of very important projects and programs for NASA, and you made a difference on so many missions. It’s very rewarding, I imagine, having those opportunities.

KLUMPP: NASA gave me a chance to do things, and paid me for doing things that I would have been glad to for free.

JOHNSON: We appreciate you talking to us, and we’ll go ahead and stop and let you get on with your day. Thank you very much.

[End of interview]