NASA MSFC Oral History Interview
Steve Johnson Interviews – Apollo/Saturn Program

Dave Christensen
Interviewed by Steve Johnson
Huntsville, Alabama – Unknown, Circa 2012

Steve Johnson: I am talking with Dave Christensen, whose long career has involved primarily being a contractor and consultant for NASA [National Aeronautics and Space Administration]. Dave, could you first talk about the education you had that prepared you for your work in the space industry?

Dave Christensen: I started out with the Guided Missile School at Fort Bliss, Texas in the early 1950s. I was drafted into the Army and I was involved in launching the Corporal rocket at White Sands Proving Grounds and leading up a launch team. This was a very important part of my education in rocketry. Then I also attended the University of Alabama, both in Birmingham [Alabama], and here. My education was based on basically Army work I had done, before I met [Wernher] von Braun and others.

Johnson: I was going to ask what brought you to the space program.

Christensen: I was also working in the aircraft industry, so I had a background in both aircraft design and rocket operations, missile operations. I was told there were a lot of activities starting in Huntsville [Alabama] with ABMA [Army Ballistic Missile Agency]. I came up and talked to one of the Germans about the program. I was convinced they needed someone like me. I offered myself and was immediately hired as a project engineer with the Army Ballistic Missile Agency. I worked for four years directly on the Redstone, Jupiter, and Saturn Programs during the Army period.

Johnson: What happened when you left the Army?

Christensen: I came back from Texas to Birmingham and worked in the aircraft industry. From there, I came to Huntsville in February 1956.

Johnson: You worked with the ABMA, Army Ballistic Missile Agency?

Christensen: Yes, I worked directly with the Structure and Mechanics Lab and I was asked to work in the propulsion group. I had a lot of background and experience in missile checkout, testing, and avionics. I was not really a propulsion engineer, but that is what I became very quickly. I became a project engineer on the Saturn H-1 rocket engine in about 1959.

Johnson: When the von Braun team left the Army and moved to Marshall Space Flight Center, you did not go with them. You went into private industry.

Christensen: Yes, I stayed with the team, but under contract. I went into private industry. I actually started my own business and I was consulting with many of the companies that provided materials and equipment for the Saturn Program. I worked with BorgWarner, Parker Aircraft. In fact, I brought Parker Aircraft to Huntsville to set up an operation. That was the first aerospace company to move to Huntsville, out in California. I was working with the chamber of commerce and the industrial expansion committee to do that. I was supporting their efforts to bring industry into Huntsville. I had many contract with Marshall and with industry here at that time.

Johnson: You did spend some time at the University of Alabama in Huntsville after your Marshall days, even after your industry days. You then got back into industry in the 1980s.

Christensen: Right. I started at the University of Alabama in Huntsville to work on the Saturn history project. The Mercury history and the Gemini history had been written and NASA Headquarters wanted a history on the Saturn Program. I wrote the proposal for UAH [University of Alabama in Huntsville] and worked for many years to get the

documents into Huntsville and to find a historian who would write the history. It took longer to write the book on how we developed the Saturn than it did to develop the Saturn. It took twelve years to get the book out. The documents are still at the University of Alabama in Huntsville. That became the first collection for the archives as well as the Willy Ley Collection. Today, that is one of largest archives on space history in the country.

Johnson: Let us go back to the period in the early 1960s when you were working directly on the Saturn Program. What were the main technical challenges in what you were doing during that period?

Christensen: Among other contracts, I had a team of people, in fact, I had over 130 doing all kinds of things, so we were doing task assignments on many different subjects. Same way in my case, I worked on many task assignments. We built the models and did the illustrations and proposals for NASA, going to Headquarters to get funds. I was right in the middle of the whole program development process. Among the things we worked on were scenarios for going to Mars. This was in 1961 and we already had our game plan laid out to go to Mars. I worked on that.

I also worked on the management information systems. I went around the country to look at different techniques that were used for very large programs. The one we picked was from Dupont because of their large chemical processes. That was worked directly into the management information systems that were accepted by NASA and used throughout NASA, not just Marshall. Those things were down at Michoud [Assembly Facility], on the west coast, Headquarters, Houston. That was one of the main projects I worked on was how to keep up with all of the logistics of the Saturn Program, which was a heck of a problem.

Johnson: Your area was not one that required testing, or did it require testing as you figured out what would work and what did not?

Christensen: I cut my teeth on testing because at ABMA, I was writing the test plans for all of the rocket engines that were being tested out at the test stands. Later when I joined industry, I joined Wyle Laboratories and we did a heck of a lot of testing for NASA, big testing, little testing. I was heavily involved in the test program from the very beginning.

Johnson: What were the challenges in testing? I know testing was almost what the entire rocket program was built on, testing little pieces and then putting them with big

pieces and then testing that. Did you feel like your career consisted of moving from one test to another?

Christensen: It did for a while, absolutely. We were testing engines, both individually and in clusters. I was heavily involved in the development of the eight engine cluster for the Saturn and later the five engine cluster for the Saturn V. All of those engines were tested with the components, subsystems, systems, clusters. It was a buildup of testing and a lot of the testing was really to wring these things out. There were a lot of failures, but that is what you want to know, where are the weak spots. Testing was a way of life. That was a carryover from Peenemünde [Germany] where they learned how to do that. It was in their genes to test.

Johnson: You were involved with numerous rocket firings on the various test stands at Marshall?

Christensen: Yes, I was.

Johnson: Can you talk a little bit about what it was like doing a test firing and what that meant?

Christensen: It was a very hectic time because of the schedule. You were trying to get ready for one test and find out what happened from the previous one. It was not just test stands, it was in the laboratories, not just engines, avionics, valves, structures, tanks, a whole series of tests. Systems tests, subsystems tests, component tests were all going on in parallel, so it was a very intense time not only here, Huntsville, but all over the country. Every one of the vendors had to go through those tests. They had to do the vibration tests, the continuity tests, structural tests, test to failure. It was a way of life. It was very hectic. There was a lot going on. And keeping up with all of that, that was a job.

Johnson: Am I gathering that you might have been involved in testing on an array of systems almost at the same time?

Christensen: Certainly. Particularly at ABMA, before NASA, that was a way of life. That is where I cut my teeth on testing.

Johnson: The work that was done at ABMA almost proceeded to become work at NASA.

Christensen: Yes, the same procedures, the same ideas were used, the same philosophy was used. ABMA was certainly the mother of all the testing that went on at Marshall, and before that, Peenemünde. This was just a continuation of a process that had been going on for many years.

Johnson: In your work, in your consulting and your contracting, did you ever have to develop and new tools or come up with new materials? If you did, could you talk about that process?

Christensen: Yes, there were a couple of things I would like to talk about. One of them was injector materials that were used for the J-2 and later the shuttle engine. One of the companies I consulted with and worked with was Pall Corporation. Dr. David Pall actually worked at the Oak Ridge Laboratories in developing the process for uranium separation. The material he came up with was a woven stainless steel that you would then censor and integrate into a woven mesh. By controlling the dimensions, you could control the porosity. It turned out to be a great product and was used initially on the Centaur, for the Pratt & Whitney engine for the Centaur. I worked with United Technologies later, so I was very familiar with that process. That process was not used on the F-1, and at the time, it was not being used on the J-2. It was a drilling process. I managed to convince NASA and Rocketdyne that they had better look at this material.

That story is in *Stages to Saturn*, but that was a real breakthrough in performance rocket engines. It was used particularly for hydrogen, it was great for hydrogen, because you can get a nice boundary layer on the face of the injector. It also was used for all the hydraulic filters because when you get vibration, filters come apart. If you get a rigid material like that, it is great for filters. It was used for filters and injectors both. It came out of, frankly, Air Force research, the Centaur.

Johnson: You had to come up with a new material. In your experience, did that happen on a regular basis across the Saturn Program?

Christensen: A lot of breakthroughs were made in explosive forming, techniques that were developed by NASA, so a whole series of things developed. By the same token, you had to borrow what was available from industry and put it in. A lot of it was modifying what was already available, just like the Jupiter engine was a modification of the Air Force engine they were using for the Thor. We were always trying to improve and get a better product. There are a lot of stories there about how they did that. There was a continuous effort to improve materials to state of the art, processes. That was just ingrained at NASA. But at some point, you have to cut it off, that is the key. You cannot just keep developing technology or you will never develop a product. One of the real challenges was when to say we cannot do anymore, we have to take this, put it into

production, out it into the process, test it, and use it. That was true not only of the Saturn Program, but the Apollo capsule. Houston was going through the same thing, North American Aviation was going through the same thing, on both the S-II stage, which was developed in California, and the Apollo capsule, which was developed in California by the same company. They had the problem in spades, cutting off the technology and bringing the product to get it ready because of the schedule. The schedule drove everything.

Johnson: I want to ask you about that, the pace of work, how fast did things have to be accomplished during the Saturn years? Was there this hanging over your head, we have to hurry a little bit?

Christensen: Yes, there was that, plus the sense that you are putting people onboard. There was a whole Manned Flight Awareness Program that was developed. Dr. Preston Farish was one of the people that really pushed that. He is deceased now, but he was one of the pioneers of that. A lot of that came from industry too where they realized we had to put people on these rockets. A lot of it came from the Air Force, a lot of it came from JSC [Johnson Space Center], a lot of it came from here. As a team, NASA had to pull together and really do the Manned Flight Awareness thing and meet the schedules. The schedules were the driving force. Money was not really a big problem. NASA

would always kick the money in because of the dream of JFK [John Fitzgerald Kennedy], Kennedy, that we would go to the Moon in that decade. That was a big factor in both the schedule and hard work everybody put in. A lot of people put extra hours in.

Johnson: Speaking of hours, can you talk about the work hours you worked at your job and maybe the shifts you had to work?

Christensen: I was not actually building hardware. I was more into consulting. I was really involved in information systems, management systems, how do you keep up with all of this stuff. I was more in that world than the hardware at that time.

Johnson: Would you say that you had to work some pretty long hours to stay ahead of the game?

Christensen: Yes, any time you have your own business, you work long hours. Absolutely.

Johnson: How about the work environment? Was it a job where you were having fun? Was it a job where everybody seemed to be on the same page? How would you describe it?

Christensen: I think von Braun as the leader was certainly a unique person who kept all that together, kept it going. As techniques he used, the weekly notes, so he had information flowing both up and down all the time. He set up a procedure. Ed Buckbee has talked about that a lot. I assume you are going to talk to him about that technique.

Johnson: Tell me about Dr. von Braun's involvement with different things you worked on. Did you interact with Dr. von Braun?

Christensen: I did more so at ABMA when I was involved in the testing of the Redstone and Jupiter, Saturn H-1 engine I was working on. I would see him quite a bit at the blockhouse. As time went on and the program grew, you did not see as much of him, but he would show up anywhere, anytime. There are a lot of good stories about Dr. von Braun. A guy say, "Hey, buddy, hand me a wrench," under a rocket over there and Dr. von Braun, he would hand it to him. (Both Laugh) I know you have heard those stories.

Johnson: Basically, directly or indirectly, he had his hand in some way on just about everything.

Christensen: Absolutely. I spent more time with him after he left NASA, frankly, than I did during the whole time that I worked with NASA, he was so busy. In fact, we published a magazine when we were at ABMA to publicize space and he worked directly on it. He wrote articles and was on the board of editors. I was one of the editors.

Johnson: Very quickly, tell me about that magazine.

Christensen: That was published as sort of a sequel to *Collier's*, which was a major magazine that got people interested in space. Dr. von Braun, as a crusader for space, there is a book by that name by Dr. [Ernst] Stuhlinger and Fred Ordway, certainly believed in public knowledge of space to get some public support. We had about eight editions of that magazine and it covered everything from the Russian challenge to nuclear rockets to photon rockets. This was in the 1950s, so this was way out working in a futurist situation. That magazine was used, we volunteered our time, but then we got so busy when Apollo came along that we could not do it anymore. The whole team had to back off. The money that was made from that built the Von Braun Observatory. We all contributed to make that observatory happen up there.

Johnson: You have already said at one point that money was not necessarily a problem, but was there any effort to control costs in the different things you were involved in?

Christensen: Yes, they were frugal, Germans were frugal. They were not wasting money, but they would not cut corners if they had to have a test done or anything. In particular when something blew up or you had a big problem that had to be solved, everybody would jump on it and fix it so we could keep the schedule going. That was a fairly common problem. Nothing is perfect. The designs were not perfect, but close enough. If something happened, you had to find out why it happened and correct it. A lot of time went into that as these problems occurred. An enring blew up or an S-II stage might blow up in California because of safety factors, so you had to go back and look at that.

Johnson: I was going to ask about dead ends in your work and how you recover from them, but testing basically exposes dead ends and you were involved with testing all the time. How were you able to recover, or was it more a question of how the testing directed you in what you were trying to do?

Christensen: It would keep you straight and make sure your assumptions were sound. We had a saying, "one sound is worth a thousand expert opinions, you do not know

until you test." I started my career in testing. I was testing Corporal missiles and had nuclear warheads going to Germany, so we had to launch four in a row. That was certainly a flight test. That is where I really started my career. It was under very harsh conditions out in the desert, sand storms, making sure those rockets were correct. That is before Redstone even. These things were deployed before the Redstone. In fact, I used to kid the Germans and say, "Hey, I had some rockets over to Germany before the Redstone." They would say, "No, no, no, do not forget the V-2."

Johnson: Were there any real surprises in testing things that you just did not expect?

Christensen: There were some, a structural failure would be one example, that exceed the safety limit. You may have made a bad assumption on how you ran the test. Setting up the test and understanding it is very critical. That was one of the things I worked hard at was putting together the right test plan.

Johnson: Can you talk about the difference between Marshall and any other NASA center? I would assume you dealt with people at multiple centers. Were there any rivalries that you could detect?

Christensen: I think there was somewhat a rivalry between Huntsville and Houston, and still is. I think when things really got down to the nitty gritty, they teamed up and worked together. For example, when the Apollo fire happened on the first Apollo because of the pure oxygen, there were people in Huntsville that had a lot of experience like Bill Reil [Spelling?], in what happens when materials get in contact with oxygen. Dr. [Eberhard] Rees played a key role in that. It became a tight team to solve a problem that was a major problem. It could have stopped the whole program. The fix was to go back and redesign the hatch and the gasses in the Apollo capsule. When things got rough, everybody hopped to, worked together, and became a real team.

Johnson: But you are saying there were rivalries?

Christensen: Yes, there were, because, frankly, the real reason I think is because von Braun had so much charisma that he got all the attention. I am sure that people from JSC and Headquarters probably resented that some. I saw it inaction because I would go to the launches. When von Braun gave his talk about what was going on, status, you could not hardly get in the room. When these other guys, who were just as important, would talk, they just did not have the audience that von Braun had. I am sure they resented some of that.

Johnson: Talk a little bit about the integration of all the different parts, projects, and designs. In your estimation from what you saw, and you had the rare ability to see things from inside and out, before and after, if that makes sense, as working with the Army and working as a NASA contractor, how did things fit together when it came to the point where it was time to put all this stuff together and make it work?

Christensen: That is called systems engineering and systems integration. That was one of the key things the von Braun team pushed so hard. In fact, they had a whole simulator that would take all the parts and make sure they would function together before they went into the real vehicle. That was called the bread board. It was a place where you could put all the components and actually exercise the sequence of events and go through the whole thing. I did some work on that myself. I did the original logic diagram, or sequence of events, for the first Jupiter missile. I did work for that myself.

Johnson: Testing in this way, was this something that was?

Christensen: Systems engineering was the name of the game, and von Braun was a super systems engineer, so he had a big picture. He could also dip right into the components, this was the way he functioned, and see where the problems were and fix

them before they gave a problem. He was very interactive as far as systems engineering goes.

Johnson: It strikes me that in developing rockets, systems engineering is crucial, maybe more so than many other fields. Did it come to its fruition, to its peak, in designing and building rockets?

Christensen: I think the Saturn and Apollo Program was the peak because it was so large and complex, it involved so many people, it involved so many parts, so many contractors. It was a masterpiece of systems integration, systems engineering. A lot of that story is in the book, *Stages of Saturn*, which took twelve years to write. The authors put a lot of effort into that. Yes, systems engineering and integration was the backbone of the Saturn Program.

Johnson: Could you describe the contractor experience in your work as a contractor? Was it a good experience? Was being a contractor for NASA when they were trying to develop a so-called Moon rocket a good experience?

Christensen: It was very good. I think the contractors really worked hard and every one of them did their jobs. I did not see anyone try to cut corners. In other words, the whole team was a team.

Johnson: How about NASA Headquarters? Did it help or interfere in the development process?

Christensen: Both, (Both Laugh) but I would not exclude NASA Headquarters. They had the best interests of the program. The administrator on down were very dedicated to the mission. I am talking about Saturn/ Apollo. If we talk about other programs, we may have a difference.

Johnson: But for Saturn/Apollo, you felt like Headquarters was part of the end solution?

Christensen: Everybody wanted to meet that mission and get that going. The only problem was, and I will say this now, after we went to the Moon, we threw everything away. The mission was just to go up there and beat the Russians, which the real mission, and von Braun knew this, was we should be putting up a stepping stone to go

into outer space, and we did not do that. We tore it all down. There are several stories about that I can tell you about later.

Johnson: Let me ask you, stopping where we did, even though you would go on to work on the space shuttle and the International Space Station, is there regret in your mind that we did not go forward with the ground work laid by Saturn V and Apollo and go to Mars or go the next step?

Christensen: Starting in 1961, we had a master plan to do just that, and the Saturn was a key part of that whole master plan. It certainly broke Dr. von Braun's heart when we stopped where we did and did not continue to develop that Saturn and use it. We had two Skylabs and only flew one of them. We had two or three Saturn Vs that we could had gone and continues to put another space station up, or anything we wanted to do. He put Skylab up, which was a space station. That was done with one Saturn launch. It took forty shuttle launches to get our current space station up. We had a tremendous capability that we wasted.

Johnson: As somebody involved with the program, how did you feel?

Christensen: I felt bad, still do. I tried my best to keep the Saturns going. In fact, I worked hard to get something going called solar panel satellites so there would be a mission and a payload for the Saturns. I can tell you that story sometime.

Johnson: Tell me that story. Tell me about what you tried to do with satellites.

Christensen: I was consulting with one of the oldest research companies in the world up in Boston, Massachusetts, Arthur D. Little Company. They go way back as a contract research firm that did a lot of work. They had put experiments on the Moon, for one thing, and one of their VPs [Vice Presidents] came up with an idea to put large power stations in space, convert solar energy to a microwave beam, and send it down to Earth and convert it back to electricity. That was forty years ago and it is still being talked about as an idea, but we do not have the transportation to do it. I was trying to keep the Saturns going for that mission. I brought Peter Glaser down to Huntsville and met with all the German group, all the American group, and all the labs and talked about that. We were trying hard to do it, but it was not in time because the Vietnam War and other things had already started shutting down the Apollo Program. The real driver in all of that was the funding just could not continue at the rate it was going at that time. It had to be cut back to pay for the war, among other things. We were having other problems in this country, so it was just not to be. I tried.

Johnson: Let us drop back a bit. How did you feel when the Saturn V, the rocket that you had helped make happen, finally flew and flew successfully?

Christensen: Fantastic. I took the whole family down to Apollo 11. I was very proud. I got to go to most of the Saturn launches as a part of the work on the Saturn history program. I was down there quite a bit for that. I was just proud as could be. Of course, going to the Moon, the mission itself was great, and the Skylab mission, which was kind of an add-on, was very successful. Everything that we touched worked fine. It was amazing when you look at how many were built, how many people were involved, how many parts had to work, and it never failed. It was unbelievable.

Johnson: Did you sense in the Saturn days that you were making history?

Christensen: I did. That is why I saved all this stuff. I knew it was a historical moment. In fact, Dr. von Braun was voted the number two in the whole world for his contributions to the Saturn Program. The Wright brothers were number one. That shows you the value in the aviation industry, I think.

Johnson: Dr. von Braun, got a lot of recognition, the same for the German rocket team. Do you feel like the rest of the people who worked on these programs, the Saturn Program, including yourself, got the recognition they deserved?

Christensen: There are a lot of unsung heroes that I think deserve more credit. Usually when you have a recognition event, it is the astronauts that seem to get all the credit. I do not think the hardworking people, including the Germans themselves, they get quite a bit, and von Braun gets quite a bit, but do not forget the American part of the team. The team was not just Germans, it was all the Americans that worked for NASA, the ABMA and MSFC [Marshall Space Flight Center] that I think deserve more credit. To answer your question, I think there is more credit due than has been shown by the media. Do not get me wrong, I love astronauts, but they seem to get more credit than other people. It is just like pilots that set records in airplanes, the astronauts set records in rockets, so it is just natural that that is where the credit goes.

Johnson: You were still involved with NASA as a contractor during the development of the space shuttle and the International Space Station development. Would you compare the challenges faced during the Saturn days, where you were doing something that had never been done, with the shuttle and the Space Station?

Christensen: You realize the space shuttle was started about 1970 and it flew in 1981, so it took a long time. If you go to 1970, there was a long pipeline of activities that fed into the shuttle, so it did not just start by itself. It had the X-15, it had all the engine development work that had been going on with hydrogen engines, a lot of work had been going on in solid rockets with the Air Force, Navy, Army. The shuttle did not just appear out of nowhere, it had a beginning whose roots go way back. It was already starting up, but there were certain technological things that had to be done, like the tile for reentry protection, the hydrogen engines that were developed, they never failed. Think about that one the shuttle. That was done here in Huntsville. The solids were developed here in Huntsville. They had some problems. The tank by Eric Engler, he designed that, incidentally. The ET [External Tank] was a very successful program except for the shredding of the foam.

The same thing happened with the Saturn. There were problems with the S-II stage. It was a very difficult project, and the third stage, because they used hydrogen. For a while, everybody was afraid to use hydrogen, but we did and the Russians did not. One advantage we had over the Russians, we bit the bullet and went to hydrogen upper stages and we still have that benefit today. They stuck to the old V-2 boosters. They are still flying those type boosters today, and we have to pay them to go to our Space

Station. We should have kept some of that old stuff too, but it worked, a lot of Saturns. (Laughs)

Johnson: Were the challenges as great for the shuttle? I realize you are still developing a new vehicle. In your mind, was it the same process, just with a different vehicle, or was the Saturn different?

Christensen: The Saturn and shuttle are different, one is brought back and reused. The problem is the cost of modifying and refurbishing and reusing the shuttle was what made it just about as expensive as throwing everything away. That was the Achilles' heel of the Shuttle Program. It was supposed to be a lot cheaper and in reality, it was over a million dollars every time you flew it, lifecycle cost. We realize that now, so just putting up the space station with forty shuttle launches, in addition to the space station costs, that is another forty million to get it up there. I think we went off on a very expensive pathway that looked good when we started, but it turned out it was not. It was too expensive. Either way it is expensive.

Johnson: If we kept the Saturn V and not had the shuttle, where would we be?

Christensen: We were going ahead with a plan to go to Mars in 1982. That was the original plan in 1961. It was still the plan in 1969 that von Braun took and delivered to Headquarters, to Tom Paine, who was the administrator. That is how they got him up there. There was a guy name Spiro Agnew that was head of the Space Council that resigned. All of a sudden, that whole program was without a sponsor because I think Paine left, Agnew left, and von Braun stayed a year or two and then he left. He saw it was a dead end. He went to Fairchild and worked his last five years there. That is when I spent a lot of time with him.

Johnson: You have basically been doing either consulting or contracting or thinking about rockets and missiles since the early 1950s. How would you sum up your career working with NASA?

Christensen: It has been great. NASA has been a tremendous organization, has done some great things, and I just hope they can keep going. It is a matter of money, the budget, and that is true of the new programs out here. Without funding, you cannot do it. The politicians and the people are going to have to demand we do more in space, otherwise, NASA will not get the money to do it. It goes right back to what von Braun always tried to do, work the grassroots, get the public interest. He knew how to work

the politicians, he knew how to work the public, but we do not have a von Braun anymore. That is our problem.

Johnson: Speaking of money, during the Saturn days, could we have done what we did in a decade with the financial constraints that NASA has essentially had since then?

Christensen: Probably not, although we had similar amounts of money. Twenty-four billion dollars for Apollo was like 125 billion or more now, which is what we just spent on the shuttle and what we just spent on the space station. We spent a quarter of a trillion dollars here in the last forty years. If that had gone into continuing the Saturn and going on out into space, we would have been on Mars a long time ago. We needed a nuclear rocket, which we had, but we threw it away too.

Johnson: There is some sadness in you about the opportunities. Do you think we wasted opportunities?

Christensen: Absolutely. I think we picked wrong programs and spent money on programs that looked good but really were not. That is neither here nor there. I think if we had had von Braun around, we would have stayed on track. I think we got off track.