ORAL HISTORY 2 TRANSCRIPT

ERNST STUHLINGER
INTERVIEWED BY REBECCA WRIGHT
HUNTSVILLE, ALABAMA – 7 MAY 1999

WRIGHT: Today is May 7, 1999. This oral history session is being conducted with Dr. Ernst Stuhlinger, in Huntsville, Alabama, for the Johnson Space Center Oral History Project, by Rebecca Wright.

Thank you for allowing me in your home, Dr. Stuhlinger, to visit with you about your illustrious career. I'd like for us to begin today by giving me your thoughts. I noticed, as I was preparing for your session today, that May 7th is a day of history that we'll all remember, was the date the Germans issued their letter of surrender for World War II. Can you give me your thoughts about that time period? And if you would like, just begin by telling me where you were and how that affected you in your career.

STUHLINGER: This time, May 7, is very [re]mindful of the time fifty-four years ago when the war in Germany ended. At that time the Americans invited a number of the members of the [Wernher] von Braun team, including, of course, von Braun himself, to come over to this country and to continue in some fashion the work which we had begun in Peenemünde. Practically all of those who were invited were happy to accept this invitation.

We came over in several different shipments. I happened to be in the third shipment coming over to this country in February 1946. We were housed at first in Texas, in Fort Bliss, in a former hospital annex which was no longer needed at that time. We were kept not really as captives, but we were under surveillance, continuous surveillance. We were not allowed to go out of the compound. We called ourselves POPs; POP means Prisoner of Peace. That's how we felt.

We were surprised at that time that we did not receive an immediate assignment to continue our development of modern rockets. As our commanding general said, we were "kept on ice" so that we would not fall into Russian hands, and also that we would be available in case America decided that a rocket development project should be taken up again.

This time occurred only about four and a half years later, in the fall of 1949. At that time, the dark weather clouds began to concentrate over Korea. There was the Korean War which threatened. At that time, it was decided in this country that America should better be prepared for another military conflict, so von Braun received the order from Washington to develop a new rocket, [a] guided missile, which could be used as a weapon of war. It should be a rocket similar to the one that we had developed in Peenemünde. It should be modernized and a little larger, and with a little longer range, but [it] should be based on what we had learned and done and experienced in Peenemünde during the previous years.

At about the same time we transferred from Texas to [Huntsville] Alabama, because our housing units in Texas were used again to be revitalized as a hospital, so we moved to Huntsville. That was the time then for us, for the von Braun team, to really get into the whorl of developing rockets again.

Before that time, in Texas, we did not have a real assignment of any kind, so we chose more or less on our own what we would like to do to utilize the time to advance our own education, our knowledge, our abilities to plan and to develop at a later time new rockets. I personally began at that time to work on a new kind of rocket propulsion, which is called electric propulsion or ion propulsion. The idea of using electrical fields to accelerate the exhaust beam of a rocket system was not new. In fact, it came up by Professor Goddard in 1903. It was further elaborated on by Hermann Oberth in 1919, 1920. He wrote about it in his famous book of 1923, which was titled [the] *Rocket for Planetary Spaces*.

Von Braun at that time—it was 1947—asked me to look into the ideas that Professor Oberth had expressed about electric propulsion. I was happy to do so, and began studying electric propulsion. It has been now a subject for me personally, which I have followed and pursued ever since 1947. The hope and the idea that a real space mission should be developed and built on the basis of electric propulsion, this idea began to materialize only very recently. In fact, last year, only, in 1998, the people at the Jet Propulsion Laboratory [Pasadena, California] began to build a spacecraft propelled by electric propulsion which would go into deep space, it would visit an asteroid and a comet, and even, later on, the planet Mars.

I was very happy to receive from my colleagues, my young colleagues at Jet Propulsion Laboratory, recently a beautiful poster which showed an image of the ion-propelled spacecraft on its way to a nearby asteroid, and the poster was signed by thirty-eight of my young colleagues and new friends at JPL [Jet Propulsion Laboratory], in golden letters, with gold ink. It was dedicated to me. I was very happy and very proud of that very nice gesture.

WRIGHT: Also let me issue you congratulations on receiving the Laurel Award from *Aviation Week*. If I can read for you, it says, "To the developers of the ion rocket engine, which after four decades of work is now being used operationally on five Hughes communication satellites and the NASA deep space spacecraft, giving a tenfold savings of fuel," and your name, Ernst Stuhlinger, is mentioned, "representing the first wave of effort that brought the engine from concept to flight in the SERT [Space Electric Rocket Test]1 and SERT 2 orbital demonstrations that started in 1964 and 1970."

Decade after decade, you have provided the NASA program with many, many achievements and accomplishments. I'm sure it's very rewarding to see them continue

moving us closer into further explorations of space. Do you have one project that you worked on that seems to have been more of your favorite than others, after all these years?

STUHLINGER: I've been with the rocket development activities now for more than half a century, and I worked, of course, in a number of different functions and fields. I began in Peenemünde working on guidance and control equipment, and later on, after we had come to this country and even [more] after we had moved to Huntsville, I concentrated particularly on projects that would utilize rockets to do scientific research in space.

I would like to mention a few of these projects which I tried to help evolve. One was the Pegasus satellite. It was a satellite which had to measure the incidence of meteoroids from space on spacecraft. We built that particular spacecraft, it had huge wings attached to the satellite itself. The wings were actually sensors for meteoroids. Each meteoroid hit made a little electric impulse which could be recorded and analyzed for the size of the meteoroid. This was done in the sixties.

Then there were some other projects in which I was involved. One was a family of three satellites which were called high energy astrophysical observatory. These were three satellites. The first one measured ultraviolet radiations from remote stars and galaxies. The next one was built to measure the X-ray emissions from celestial objects, and the third one used to measure cosmic radiation from outer space. These three satellites were quite successful and gave us a large amount of new information about radiations from space.

Then there was the big Hubble Telescope, the idea to use satellites to carry telescopes and to look deep into space under conditions which were far more favorable than they would exist on Earth, with the atmosphere and the dust and disturbances around. The idea to do that was, of course, not new. Professor Oberth, in his book, wrote about the fact that we could use satellites to launch astronomical telescopes and do astronomy.

Then later on in the sixties, there was a very fine scientist in Princeton [University], Professor Lyman Spitzer [Jr.], and he had the idea that we should now try to really build a satellite with a huge telescope on it to do astronomy from orbit. Professor Spitzer and I worked together. My part of the work was to study and to find out how a large telescope could be put on a satellite. Professor Spitzer made a lot of propaganda among scientists for the project. We were successful. The project evolved and developed, and it is known today as the Hubble Telescope.

The Hubble Telescope is probably one of the finest achievements of our space program, as far as scientific research is concerned. We continue to receive beautiful pictures of stars, of star groupings, of nebulae, cosmic nebulae of galaxies which could never be obtained from the surface of the Earth.

Then another project in whose evolution I was directly involved was the Skylab Program. Skylab was our very first station in space, manned space station in orbit. It had been the idea of Professor von Braun for a long time, to use an empty tank of a rocket, a satellite-launching rocket, to provide space for astronauts and for instruments in orbit after the stage had arrived there and had used up all its propellant.

That idea on von Braun's side came to fruition in the early seventies. We did build a kind of a first space station on the basis of the tank of the third stage of the Saturn V rocket. It was filled with instruments, scientific instruments. In particular, it provided a lot of room for astronauts. The Skylab spacecraft offered room actually for three crews of three astronauts each, for about 184 days in orbit. [More than 250] scientific experiments were made, and a great deal of scientific information was obtained from these flights.

We had prepared three of these satellites, and the idea was that the second and the third satellite should learn from the preceding satellite, so each satellite's station would be, so to speak, an advanced version of the previous one. We were only allowed to launch the first one, Skylab 1, and after that, NASA decided not to continue.

We were unhappy about this decision. We had been preparing three Skylab spacecraft, and we hoped to launch all of them and to utilize all of them, but the decision was made to use only one of them, so the Skylab Project remained a one-shot affair.

WRIGHT: What was your primary role in Skylab?

STUHLINGER: The idea of Skylab was that one should first build a station that could be occupied by astronauts who could live there for some time, and we wanted to study how they could live there, what their needs will be, how well they could function under weightlessness, how much they could do in the way of scientific research and scientific observations. That was the first aim. The second aim was to put as many scientific instruments on board of the satellite as possible.

It was my task to contact scientists on the outside of our own center [Marshall Space Flight Center (MSFC), Huntsville, Alabama] and outside of NASA, scientists at universities and institutions. It was my task to inform them of the possibilities and to try to develop some enthusiasm on their part to prepare instruments, to fly them, and to utilize the opportunity of doing research under weightlessness and in outer space.

The Skylab 1 mission had about fifty-six different scientific instruments, and there were more than 100 scientists on the outside of NASA who participated with their instruments. It was my task primarily to establish contact with these scientists, to help them to find out how they should prepare their instruments. This was quite a large effort to get them all, so to speak, together and into a working program, but it worked well and the Skylab turned out to be a very useful and very efficient and successful operation.

WRIGHT: Was it a challenge to talk these scientists into participating, or did they welcome the opportunity to be part of the Skylab Program?

STUHLINGER: Well, it was for me a great challenge, and I really enjoyed it very much. I made a number of very good friends in this activity. It was very satisfactory work on my part, for me.

WRIGHT: And the scientists that you get to know and had a working experience with, that participated in Skylab, they were glad that they had decided to become part of that program as well?

STUHLINGER: I'm sure many or even most of them were. Some of them were not too fortunate and too successful with their instruments, for various reasons, and they were not too happy about their own situation, but in general I believe that most of them were happy and appreciative of the opportunity to do research under space conditions.

WRIGHT: Of course, prior to Skylab, you were instrumental in working with the rockets that brought man to the Moon. Could you share with us some of your responsibilities and duties and accomplishments during that program as well?

STUHLINGER: The idea to go to the Moon with astronauts, manned mission to the Moon, was, of course, not new for us. Even in the past century, people talked about that. When von Braun was a young boy of about fourteen years old, he decided that he wanted to build rockets that could go to the Moon and even to Mars. He stuck to this aim in his life, from that early age on, and looking back over his life, it was a straight line of determined effort to just achieve this flight, first building precision rockets, then fly to the Moon, and then, as he had hoped, later travel to Mars.

The possibility to build a mission for the Moon became realistic in von Braun's thoughts around 1955. It was the time when we had built the Redstone rocket. We had also built the next one, that was Jupiter, and then the idea was relatively natural for von Braun to build an even bigger rocket that could go to the Moon, which later on was called the Saturn. He had the idea and really began to think in terms of hardware development in about '55, '56. At first, of course, he kept it quiet, to himself, because it was not the time yet to make much propaganda for it.

But then, in 1958, he saw the opportunity of developing a rocket engine, a big one, which would be needed to power a rocket that could go to the Moon. He worked close together with one of the industries, Rocketdyne in California, under a gentleman by the name of Sam Hoffman. Sam Hoffman had been a good friend of von Braun's since the early days after our arrival in America in 1946. He was eager to participate in a project like that, and then with the help of some NASA headquarters people in Washington [DC], particularly Dick Canright, von Braun could begin a project, a paid project, development project with Rocketdyne to build that big rocket engine, which was later on called the F1 engine. It was the engine that powered the Saturn V to the Moon.

Then came that very fortunate situation that we had a young President who could develop enthusiasm for a trip to the Moon. Von Braun was very successful in persuading first Lyndon [B.] Johnson, the Vice President, and then President [John F.] Kennedy, to begin and to develop a project which would actually lead to a landing on the Moon. It was a complex situation. There were many political aspects. For example, the fact that President Kennedy wanted to do something, as he expressed it, something great which would show to the world that America can still do great things and could beat the Russians, so he, fortunately, agreed with von Braun, proposing that there should be a manned landing on the Moon.

The lunar rocket was planned and actually built from the end of the fifties [on]. Then in 1961, when President Kennedy gave his famous speech in May '61, President Kennedy said we should do it before the decade is out. So that gave us a time schedule which, of course, meant the beginning of very intense work. It was work in von Braun's team, but at the same time, of course, in the team under Bob [Robert R.] Gilruth in Houston [Manned Spacecraft Center (MSC)], was later on called the Johnson Space Center [JSC].

The partition between the two main centers, von Braun's center and Gilruth's center, was that von Braun should do the development of the vehicle itself, the big rocket, and the Houston people, under Dr. Gilruth, they should take over the manned portion and include the training of the astronauts and building of the habitation capsules and everything that was needed to keep the astronauts in a living and working condition.

WRIGHT: Speaking of astronauts, Alan [B.] Shepard [Jr.] had just made his flight three weeks prior to President Kennedy's speech.

STUHLINGER: Right.

WRIGHT: Were you surprised when you heard his announcement that we were going to go to the Moon before the end of the decade?

STUHLINGER: Of course, we people around von Braun and in his team, we had been familiar with thoughts of going to the Moon for a long time, and we had, in one or another way, helped to make the plans and to study possibilities. We had hoped that President Kennedy would make that announcement, but when he made it, we were very happy, but it was not a real surprise for us. It was natural for us that it should go this way.

WRIGHT: From then on, you were very busy. How did your time schedule and your tasks change once that announcement had been made? Were you busier? Were your days longer?

STUHLINGER: All of us, we were extremely busy, of course, because it was a great project, very involved, and we had to do a number of different things—develop the propulsion system for the rocket, the guidance system, the details of going into orbit and doing some maneuvers in orbit. Also, we developed a very close cooperation with Houston, with Dr. Gilruth's Space Center. We had, of course, many joint meetings. It was a joint effort to build that rocket, and it was very hard work for everybody who was involved one way or another.

One of my tasks, for example, was to find out as much about the details of the Moon that would expect the astronauts. Nobody knew what the lunar surface was made out of. However, there were a number of scientists in the country who had thought of that before and who were quite willing to pitch in and to help, planning for details of that mission. It was one of my tasks to contact the scientists and to make them aware of the problems, and to try to get their knowledge and their will to cooperate with us in planning for the lunar mission.

WRIGHT: Did you find lots of differences between their ideas and their knowledge of what was there?

STUHLINGER: Yes, there were some strange ideas. For example, one or two of the scientists thought that the lunar surface would be covered with very fine dust, and that the astronauts would, so to speak, drown in the dust immediately, and would not be seen again. This was, of course, not so. The lunar surface was quite solid, and one could walk on it and one could even drive a little moon buggy on the surface. It was dusty, but it was quite solid.

WRIGHT: How were you able to gather their knowledge and then share a conclusion on a topic that no one knew for sure? How were you able to pass that information on with confidence?

STUHLINGER: Well, we had many visiting scientists here in town. We had conferences with them. They gave us presentations of their ideas. So it was a very lively exchange of knowledge and of anticipation and proposals. It was a close, very close cooperation between the scientists from the outside, the scientists here in our Center on the inside, and the engineers, of course, who had to build the systems, the moon buggy and the space suits and the landing craft and things needed to really make a landing on the Moon, and come back again to Earth later on.

WRIGHT: Share with us your thoughts of when you actually saw the Moon dust and the rocks, compared to the thoughts of what you believed they would be. Were you happy that you were so close at being correct? Just share with us what those thoughts were.

STUHLINGER: Well, at the moment when we saw that Neil [A.] Armstrong came down from the spacecraft and took the first steps on the Moon, I am pretty sure that most of us, including me, we held our breath. Does he sink in or does he find solid ground? When we saw that he could stand on the Moon and could take a step, and a few steps, even, we were very much relieved. But actually we said to ourselves, "Well, that's what I thought it would be." [Laughter]

WRIGHT: Were you with your group of friends as you watched that, or were you home? Where were you when Apollo 11 landed?

STUHLINGER: When the landing occurred and when we first saw that on the TV (it was quite crude at that time, still) when we saw Neil Armstrong come out, I was here in the Marshall Center. Members of the Marshall Center were together in a big room, and we saw it on a television screen.

WRIGHT: I'm sure there were lots of smiles on lots of faces in that room. Then, of course, when they left, it must have been a joy to you to see them very safely—

STUHLINGER: That is correct. The real relief and feel of accomplishment for us people occurred only after they had been fished out of the ocean again and were on board of the boat, the ship.

WRIGHT: Many, many decisions had to be made before they could go to the Moon and, of course, safely leave and return to the Earth. One of those on what type of rendezvous that would be made and how the whole operation would happen safely and securely. Would you share with us some of those times, or maybe even some of the moments of the discussions that were held, making those important decisions that very historically have been very successful?

STUHLINGER: The interesting fact is that at the time when President Kennedy promised that we would go to the Moon in this decade, at that time it was not yet known to the people behind the project how to go to the Moon, which way to approach it and how to go.

There were three basic ideas on how to do it, the first three modes of going to the Moon. The first was called the direct mode. In this case, one would have to build a new rocket, not a Saturn V, but one twice as big, called Nova. It was existing only on paper and in the minds of a few planning people, but it would have been a huge rocket. It would have

been very costly to develop it, and it would have cost much time to develop it, to build it, to test it, and then to use it, and it would have been hopeless to do the lunar landing in that decade if we had gone the direct mode.

But in that mode it would have been a five-stage rocket. The first three stages would take the big spacecraft into orbit, Earth orbit, and then the fourth stage would take the manned capsule to the Moon, [and] land there. It would fly out there, turn around, so that the exhaust of the rocket, the thrust of the rocket, would break the fall down. You could land on the Moon. And then later on, the fifth stage, would use the fourth stage as a platform, so to speak, would fly all the way back to Earth. It was a relatively simple concept in thought, in theory, but it would have needed a lot of development and, as I mentioned, a huge rocket to begin with.

So that direct mode was not possible to do in that decade, even though our colleagues in Houston, Gilruth and his people, they liked that method because it would have been simple, relatively simple, for the life capsule part, for the landing vehicle, and then the astronaut. It would just be straightforward to the Moon and back to Earth again. They liked it, but they agreed, at least later they agreed that it would be too big a project to do in that decade.

Then there was the second mode, which was called the Earth orbital mode, EOR, Earth Orbit Rendezvous. That was the mode which von Braun and his people had proposed. In that particular case, one would take two Saturn Vs. Saturn V was being built and was being developed. So it was existing, so to speak. One would take two of them. The two of them would go at almost the same time into Earth orbit. One of them would carry the spacecraft to the Moon. The other one would carry fuel. Then the first one would exhaust its fuel going into orbit, but the second one would have enough fuel aboard to tank up, to fill up the first Saturn. So it would be full of fuel again, and it could fly to the Moon and do the

same as the direct mode would have done, and will land there, and take off at the last stage again and come back to Earth. That would have been a possibility.

Now, after some planning time, there was a third mode which was proposed by Mr. [John C.] Houbolt, Dr. Houbolt. He said, "Well, we do not need to take two Saturns; we can do it with one Saturn if we do the rendezvous in lunar orbit. If we go there with our capsule, go into orbit around the Moon, the capsule will contain a landing vehicle that will detach from the orbiting vehicle around the Moon. It will detach and go down to the Moon, and then one half of it will stay on the Moon and be a launch platform for the last stage that will take the astronauts up to the lunar orbit again. They would go back to the orbiting part, and the orbiting part would fly them back to Earth." It was called lunar orbit rendezvous. This was relatively simple, as far as the beginning of the mission was concerned. It could be done with one Saturn V and no more. That was a great advantage.

However, there was hesitation among practically everybody at first, particularly the people at Houston and the people in Huntsville. The Houston people said, "Well, if you do it this way, we have to do the detachment of the lunar landing vehicle from the lunar orbiter behind the Moon, on the rear side of the Moon. We cannot have any contact. We cannot see them. We cannot have radio contact, because they are on the other side. We have to leave it all to the computers to go through that. That is not a comfortable thought."

Von Braun said, "Well, if we did it the other way, the EOR, the Earth Orbit Rendezvous, then we would have several additional benefits from that development. We could develop the technology of Earth orbit maneuvers, like refueling and exchange of components. We would learn from that, so it would be better. Also we would not have to do that maneuver on the other side of the Moon, because our computers are not that good yet."

So there was a lot of thought about which way to the Moon. The first one, the Nova, was left out pretty soon because we didn't have the big rocket to do it. So it was between the Earth orbit rendezvous and the lunar orbit rendezvous. There was a lot of discussion. Dr.

[Robert C.] Seamans [Jr.], later on, said there was no other project in our space program that saw so much discussion and so many committees who looked into the details. There was one million man hours of work going into these studies for about one full year. There were studies and studies made, and committees and committees established, and views and opinions were pitched against each other without much progress.

Finally, von Braun said, "Well, we cannot go on like that. Our decade is ticking off and we have not even found out how we will go to the Moon. We have to come to a decision."

Gilruth said, "I do not like that. We don't have good enough computers to do that rendezvous on the rear side." However, something very important happened at that time. There was a fellow at IBM, Mr. [Clinton H. Grace, Facility Manager of IBM at Huntsville]. He's still a well-known figure here in Huntsville. Metcalf developed the IBM computer in a huge forward step to an unheard of reliability and accuracy.

Then Gilruth one day came to von Braun and said, "I have now dropped my reservation against the computer. I have seen the new computers and they are good enough so that we can do the rendezvous on the rear side of the Moon. I'm confident that it can be done."

And from that moment on, von Braun switched over and said, "Okay, Gilruth has now accepted, so I will accept it also, because we have lost so much time already, we cannot go on forever like that. We will run out of decade if we do not begin to do something, so let's go with the lunar orbit rendezvous."

Von Braun was, at first, with his consensus, he was alone among his people. [Laughter] Because we had helped him for a long time to support the Earth orbit rendezvous, but he was so convincing in his arguments, we all agreed with him immediately. So from that time on, it was only lunar orbit rendezvous for von Braun, for Gilruth, anyway, and for the co-workers of von Braun and the co-workers of Gilruth, but not everybody in

Washington [DC] agreed. There were some people, among them Jerome [B.] Wiesner. He was the scientific advisor to Kennedy. He said, "No, we should do the EOR, the Earth orbital way. That would be the more promising way." But finally Gilruth and von Braun won over and could convince Mr. [James E.] Webb—he was the administrator of NASA at that time—to back their decision to do it with the LOR, the Lunar Orbit Rendezvous. From that time on, it was then the way to go.

It was done, and we were fortunate, in spite of this terrible accident of the Apollo [1] capsule which burned up and killed three astronauts; in spite of that, we could do it within the decade.

WRIGHT: Do you believe it was the turning point, it was the catalyst to get you moving faster toward getting a man on the Moon?

STUHLINGER: Well, it was necessary that the decision was made how to go to the Moon, and then to develop the components. I think the real turning point was the computer, that convinced first Gilruth and then von Braun, and they then convinced the people in Washington, Mr. Webb and others in Washington, and that's how it worked.

WRIGHT: The early days of building the rockets for the Moon, were you primarily in Huntsville or did you also go down to the Cape [Canaveral, Florida—later Kennedy Space Center (KSC)] and watch some of the testing there?

STUHLINGER: There was a lot of close cooperation between Houston, of course, and the Cape, Cape Kennedy. It was a very close relationship all the time. We built altogether thirty-two Saturns—Saturn I, Saturn IB, and Saturn V. These were three members of the family, each of them bigger and better than the previous one. We built thirty-two of them,

and all thirty-two were launched, and all thirty-two were successful in the launching. Not all of them were successful in the upper stages. We had some problems at first with the hydrogen stage. But the takeoff from the launche was complete and correct and successful for thirty-two out of thirty-two. Hundred percent success.

WRIGHT: Wonderful. It must have been very wonderful for all of you to see your rockets moving toward the Moon and not for the purpose of how you got involved in the rocket business.

STUHLINGER: Absolutely. Absolutely. Von Braun said sometime later, he said the most beautiful aspect of the lunar program was that it allowed us to develop our rockets only for peaceful purposes.

WRIGHT: When you first moved into the rocketry business, you had just come from the Russian front lines as a German soldier?

STUHLINGER: That is correct.

WRIGHT: And so did you have any idea, when they put you in for your transfer, of what you would be doing when you arrived?

STUHLINGER: Well, see, Peenemünde, the activities in Peenemünde started in 1937, under the auspices of the Army, but it was a secret project, of course, and it was not well known. In fact, only very few people in Germany knew at that time what was done in Peenemünde, and that the huge development program was under way there. I was a soldier at the Russian front, but I obtained an order to come back to Peenemünde. The order said, "You are to

come back to Germany." I got it deep in Russia, the order to come back and to report to Peenemünde. I was a PFC [Private First Class] at that time. I asked my sergeant, "Where is Peenemünde?" He didn't know. The officers didn't know. Nobody knew. [Laughter]

So I go to Berlin, and they know where Peenemünde is. So I went there, to Berlin, and found out how to go to Peenemünde, and then I still didn't know what they were doing there. I met with one of the supervisors, and he took a piece of paper and drew the rocket. I said, "For heaven's sake, is that what you are building? This huge rocket?" He said yes. Then I said, "Who is the head of that? Who is doing all of that?" "Well, it is Dr. von Braun, Professor von Braun." He was a professor at that time. It was Dr. von Braun.

I was struck with awe when I saw this huge thing that was under development, with all the new technologies of which I had no idea. Most people had no idea. The engine, you know, the chemical rocket engine, the guidance and control system, the supersonic aerodynamics, they were all completely new things for me and for other people, too.

WRIGHT: How much time had elapsed from the time that you left the Russian front until you took this new task?

STUHLINGER: Well, it took me about five days to travel from the front line where I was. Actually it's a story of its own. It was a retreat from the Stalingrad front. You may know Stalingrad, the turning point in the war. I was there, and I was then under retreat from there. It was a very chaotic and, for many of us, a deadly situation, but I was lucky and survived the cold wintertime, 1,000 kilometers, 600 miles on foot through the wintery Ukraine, only snow and ice. I survived. I was among a few who survived.

I then caught a train back from—I don't know whether you know these locations. It's too long to tell all the details. Anyway, in Dnjepropetrovsk, that's a Russian city, I got on the train which took back the wounded soldiers, and I could hitch a ride on that train. Took five

days from there to Berlin. In Berlin, of course, the town was bombed out a lot. It was a chaotic situation. Anyway, I made it to Peenemünde somehow.

WRIGHT: And began a new life.

STUHLINGER: A new life. Sure. Sure.

WRIGHT: Were you then at the time by yourself? Were you still a single person?

STUHLINGER: I was. I came over to this country in early 1946. I was not married at that time; I was a bachelor. Many of us were. You know, the war was no time to get married then, for any romance. There was no time. So many of us, we were bachelors. Von Braun, too.

When we came to Fort Bliss in 1946, we stayed there for almost five years, and then from there, change over to Huntsville. On my way from Fort Bliss to Huntsville, I took a detour through Stuttgart, in Germany, and I knew of a young lady there. I asked her whether she would marry me and would come to America with me, and she said, "Yes, I will." And here she is.

WRIGHT: It was a good decision. That's quite a change from Germany to El Paso, Texas, and then to Huntsville, Alabama. Was there anything as far as the environment and the terrain? Were there a lot of similarities or was it so very different?

STUHLINGER: Well, I like nature very much in all of its versions, and I liked the landscape in El Paso very much, the desert and the mountains and all of that, so I really felt attached to that. But on the other hand, we were not allowed to mix with the population, only very

sporadically, and not really. We were living in a compound together, but when we came here to Huntsville, the doors opened. We could live and rent houses, and even build houses wherever we wanted to. Our children could go to any school they wanted to. We could join churches and other civil organizations. We had immediately nice neighbors, and the neighbors were very friendly with us, to us. Everybody called us first names, which was unusual for us. Anyway, it was an opening of a new life for us in Huntsville here.

WRIGHT: And many of you contributed to the community.

STUHLINGER: That is right.

WRIGHT: I understand you helped start an observatory.

STUHLINGER: Right.

WRIGHT: Would you share with us why you felt that was an important contribution here?

STUHLINGER: That was, of course, von Braun's idea, again. Actually, it's a story of its own. It's in the book here [*Wernher von Braun—Crusader for Space: A Biographical Memoir* by Ernst Stuhlinger and Frederick I. Ordway III]. By the way, it is still existing today. It's very active, has a number of younger members who are very active. We are proud to say that it is the biggest private observatory in the Southeast. We have a number, I think about a half a dozen, telescopes, large and beautiful ones. Many events, public shows. Star parties, where everybody can look through the telescope and look at the stars. Lectures are being given. A very active thing.

But we were also quite involved in other activities, like the symphony orchestra here in town, ballet organization, theater organization. Many of us became active in churches, local churches. Schools. Our children went to school right here on the mountain, and it was—well, we grew into the community quickly.

WRIGHT: It became home?

STUHLINGER: Surely became home.

WRIGHT: In El Paso, you were in a cloud of secrecy, and then, of course, in Germany your work was in a cloud of secrecy.

STUHLINGER: Right.

WRIGHT: But did you feel a different type of secrecy? Did you ever feel in danger when you were in El Paso, as you might have when you were in Germany? Or did you feel safe in both places working on your projects?

STUHLINGER: Well, it was two different worlds, you know. The danger in Germany was, of course, not other people, but the bombs and the prospect of the end of the war. Everybody knew—almost, I would say 98 percent knew that the war was lost and that it could only end in chaos and catastrophe and a destroyed country, and this was the case. So nobody knew whether he would survive the next bombing raid. So when you ask whether we felt safe, we did not, but it's a situation where you get used to, so many of your friends and relatives are lost in the war, and you just say, "When will I be next?" So that's one situation which was completely different here, of course.

El Paso was a peaceful place. We had very little contact with Americans at that time. We were under Army auspices and Army hospitality, I should say. We had nice relationships with our officers and those Army people who worked with us. There were some good and real friendships, but also, of course, some other relations which were more formal. After all, we had been in a terrible war for six years, with America—four years. So it's not surprising that there were reservations on some people.

The enlisted men who were working with us, some of them had just come back from Germany and from the war, and had been involved in the shooting war over there, and all of a sudden there were the Germans around them. It's an unusual situation, to say the least.

WRIGHT: You were a survivor of many types.

STUHLINGER: Yes, yes, yes.

WRIGHT: When you were a young boy in Germany, you grew up to study physics.

STUHLINGER: That is right.

WRIGHT: What did you want to do with that knowledge? How did you want to apply studying physics?

STUHLINGER: Well, at that time there was a new branch of science slowly developing; that is biophysics. Do you know what that means, roughly? It was very new. I don't know how many details you know about that, but in physics there had been a real revolution which led to a very profound new knowledge, the relativity theory and the quantum theory. We learned

during the early part of the century, we learned much about the atoms and the subatomic particles. Cosmic rays, that was my particular field at that time.

So physics had advanced very greatly during those decades. Not so in biology. It was just a beginning, the very beginning when people began to learn a little bit more about a few things like the laws of heredity, the genes, the chromosomes, but there was no knowledge of DNA [Deoxyribonucleic Acid], for example. It was not known at that time. But one did begin to learn some of the details, and then there was the expectation among the scientists that biology, too, would perhaps undergo a change, a new phase of development like physics did a couple of decades earlier. There was anticipation at that time that there would be a kind of similarity between the evolution of biological sciences, and to those developments that had occurred in physics.

The new term which was created was "biophysics." It's a combination of "biology" and "physics." I had always great interest in nature. In fact, my two subjects in my academic education was physics and zoology. I wanted to combine the two later. I took first a Ph.D. in physics, and then I thought I will continue my studies in biology and then combine the two and work in biophysics. That did not occur. In 1938, the splitting of the atom, of the nucleus, was discovered by [Otto] Hahn and [Fritz] Strassman. You know probably uranium fission. Every physics institute at that time in Germany and in this country and other countries, almost overnight, worked in nuclear physics, then in the splitting of the nucleus and attempts to utilize the energies that could be freed by splitting nuclei.

I was also in that activity in Berlin from 1936 on, under Professor [Hans Wilhelm] Geiger, who was my thesis professor, and then under Heisenberg. You may know the name [Werner Karl] Heisenberg. We worked very energetically on the problem of utilizing the energy of nuclear fission. There were actually two directions that this work took. One was an attempt to build a bomb, a nuclear bomb, and the other one was to develop reactors that could produce energy and could be a source of energy for terrestrial uses.

The person who was in charge of the German effort was Heisenberg, Professor Heisenberg. He said—and I was present when he said it, it's also in the book—he said, "We can do two things. We can build a bomb and we can build a reactor. As scientists, we do not want to build a bomb. That's too terrible. It would be too destructive, and we should not do that. We should keep our fingers off here. We should develop the atomic energy as a source of energy for terrestrial uses, electricity and things like that."

So I worked in that field in Berlin, but then came the draft office and took me out and sent me to Russia. That happened to many of the young people at that time. Then came, one and a half years later, the order to go to Peenemünde.

WRIGHT: Quite a change from one to the other. Did you easily adapt into what was going on in Peenemünde? Were you able to learn very quickly what they were doing?

STUHLINGER: Yes, yes.

WRIGHT: Could you tell us who you worked directly under and what were some of your first assignments there? And, of course, how your responsibilities grew.

STUHLINGER: Well, at that time, during the first years of rocket development—in fact, that is still correct today—there are three major areas in rocket development. One is the propulsion system, the motor, the rocket motor. The other one is guidance and control, which keeps the rocket on its straight path and helps it to find its target, be in on Earth or in space. The third is supersonic aerodynamics, because part of the rocket flight occurs in the air, in the atmosphere, at high speed, supersonic speed, and the aerodynamics for that kind of flight had to be developed. I was in the second one, active in the second one, the development of guidance and control equipment.

WRIGHT: Was there anything for you to use that had already been established, or did you create so much of what you did from nothing?

STUHLINGER: A number of the developments which we had to do were very basic. For example, I don't know how much you are familiar with the rocket mechanics and flight mechanics. When you want to get to a given target, be it on the Earth or in space, you have to make sure that the rocket follows the predetermined path correctly. So you have to steer it, to control it. The way to do it for a rocket would be either by radio or by so-called onboard equipment or inertial equipment which is independent of anything that is connected to the Earth.

This so-called inertial guidance and control system will have to do the following. The only thing that one can measure on board is acceleration. One cannot measure the velocity directly, but one can measure the acceleration. Can you follow?

WRIGHT: Yes.

STUHLINGER: So we had to build an accelerometer which can measure the acceleration in this direction, and also to keep it straight in this direction and in this direction, and in the roll direction. We had to measure the acceleration and then integrate it to form the velocity. Is that something you understand? To integrate acceleration, will provide velocity. If you integrate a second time, you get the distance.

So by having instruments which can first measure the acceleration, then integrate the measurement to obtain velocity, integrate it again to measure the distance. By doing that, you can, so to speak, tell the rocket at any time where it is in space, how fast it is flying, in what direction it's flying, and where it is exactly. But these instruments had to be developed,

and they have to be very accurate, and they have to be very reliable. That was new at that time. One didn't have instruments like that before. One didn't need them.

There were some tentative beginnings for instance, on airplanes, but it didn't amount to much. We had really to begin from scratch, to invent. It was an engineering invention based on scientific principles, but then the end result had to be an instrumented technical entity.

WRIGHT: And you were able to watch your idea turn into reality. Would you share with us how it felt to you as you watched your instrumentation become part of a rocket that left the Earth and go on into the outer space and work so well?

STUHLINGER: Well, we were working in a field which was entirely new, of course, and everybody knew that. But I would say the individual reactions by the persons were different. People are different. No two are alike. Some of them—that was particularly true of von Braun himself—but for some of us, and I was one of those, we thought that the real aim of the rocket was out there in space, not on the ground, not as a weapon, but out in space. That was not a new idea. Oberth had written about it. [Konstantin E.] Tsiolkovskii, a Russian, had written about it. [Robert H.] Goddard had written about it, that we should use rockets to explore outer space, the Moon, planets, asteroids, comets, and so on.

That was an idea which was very strong in von Braun himself ever since he was a young teenager. And some of his co-workers—I was among them—we had about the same idea. We did not see our rocket work as work for a weapon. We thought that it would be a way for mankind to go into space and to explore more of the world than what we were able to explore before the Rocket Age.

WRIGHT: Through all those days that you were at Peenemünde, did you retain that hope that one day your rockets would go in that direction?

STUHLINGER: We sure did, but we were not allowed to talk about it. Von Braun, one evening during a little party, was uncautious, and he said, "Well, of course our rocket finally, eventually, will be a rocket for Mars and not for England." And there was some spy around and accused him of not supporting the war effort, and he was jailed. He spent two weeks in jail. And only because of intervention of [Walter] Dornberger was he released later on.

WRIGHT: Did you know that he was in jail during that time he was missing?

STUHLINGER: Yes.

WRIGHT: They informed the workers that that's where he was?

STUHLINGER: Well, it was by word of mouth. They said they took him off, put him in jail, but we didn't know more. Life in a dictatorship is very, very different from normal life. Many people who write about our time in Peenemünde and previous times in Germany, they have no idea what it means to work under a dictatorship. Life is completely different.

WRIGHT: I would imagine that you have no contributions on saying what should be done. I guess you're always told what has to be done.

STUHLINGER: Absolutely. Absolutely not. I should modify it a little bit. The SS [Nazi special security force] people—you know what the SS people were, probably—and [Adolf] Hitler himself, they wanted to use the rocket as a weapon for the ongoing war, but that was

not from the beginning. That was from 1943 on, only from the time when the air war in England was lost for us and the submarine war was lost for Germany, only then did Hitler remember that there was that rocket out in Peenemünde, and let's see whether we can use it for our war. So the SS was put in charge of doing that, and they enforced the mass production of the rocket. They even did it and enforced it in the Mittelwerk Factory, you know, many of the workers being in concentration camp inmates. It was a terrible situation.

Anyway, von Braun was trying to avoid that, and he pointed out again and again, "It's too early. Our rocket is not yet ready. It is not yet reliable enough. It's not accurate enough, and it will not be able to be of any real effect in our present war condition, so let's not do it. Let us continue to develop it." But that was not accepted. The SS was—they were technically not in any way proficient and knowledgeable, and they said, "Well, we'll build the rocket and we'll build 100,000 per week or per month, and we'll win the war this way." This was, of course, nonsense. Von Braun tried to point that out, but he was completely not listened to.

WRIGHT: I know that von Braun had several encounters with Adolf Hitler himself. Did you ever have a time where you were also in the presence of the dictator?

STUHLINGER: I saw him a number of times at close distance, like you and I, but not in a personal way. He gave his speeches once in a while, and then we young people were more or less forced to be there, to attend and stick up our arms, but that was about all.

WRIGHT: Your exit from Germany, many have called it escape from that. Did you consider that as well, or did you see that as a chance to begin a new life?

STUHLINGER: Well, our leaving Germany to go to this country was not an escape, but our leaving Peenemünde and going south was an escape, and we escaped because the Russians were approaching. That's also a strange story in the book, how it happened. Von Braun got two orders. One was from the county commissioner, where Peenemünde was, Pomarania, and he said, "Every man stays here and takes a gun and a bazooka and fights the Russians when they come. To the last man, you fight." And the other order was from Himmler. [Heinrich] Himmler was the chief SS man. Himmler said, "You all pick up your things and move south to Bavaria, and you go there to Garmisch." You know Garmisch-Partenkirchen in Bavaria. "You go there and you wait until further orders."

So von Braun had the two orders, and he could select which one to follow. He selected the one from Himmler that said, "Go south. Take your things with you," because von Braun and, of course, everybody who was halfway reasonable, would say it's useless and senseless to fight to the last man when the Russian tanks are coming, and we have guns in our hand and hand grenades. So it was absolutely senseless.

WRIGHT: I guess that's how you felt as well? You were ready to go south and not stay and fight?

STUHLINGER: Oh, yes. Oh, yes. Oh, yes. Fighting would have given no chance at all to survive, even. So we moved south. That's, again, a very involved story. It's again in the book here how we went south and finally ended up there. In May '45, after Hitler had taken his own life, the SS all of a sudden disappeared when Hitler was no longer there.

At that time, von Braun said—he and a number of his people, about thirty or thirty-five, but not me, I was at another place, they were in a little mountain resort place near Garmisch in southern Bavaria, and von Braun said, "We cannot sit here forever." We knew that the Allies were approaching, the American troops were approaching that part of Bavaria,

and von Braun said, "We can't wait forever here. We have to do something." So he decided that he would make contact with the approaching troops.

One of his co-workers and people around him was his brother, Magnus von Braun, and Magnus had the distinction of being fluent in English. The reason why he was is a very interesting one. He was born and raised in Berlin, where his father was a Minister of Agriculture in the former government before Hitler. So it was a well-to-do family. His mother had a nanny for her children, and the nanny was from England. The nanny took care of little Magnus and taught him English before he learned to speak German. So he got English, so to speak, into his system before the German language, so he was quite fluent in English. He's still alive, by the way. Magnus is still alive.

So he was put on a bicycle, and he took a little stick and put a white handkerchief on it, drove down the mountain. That place was up in the mountains. He drove down with the bicycle until he met American troops. Sure enough, there was a place on the road where four tanks were just sitting and standing there, and he was stopped by a Sergeant [Frederick P.] Schneikert. His picture is in the book. Then Magnus said, "Well, I am one of the group of von Braun, of these rocket people, and we are up there and waiting for you." [Laughter]

Sergeant Schneikert said, "You are nuts."

Magnus said, "No, no, I'm not nuts. It's the truth. Come up and see."

Then Schneikert talked to his lieutenant, and the lieutenant, he felt that there was something great happening, and so they went up by jeep and met with von Braun. That is how the contact was made. The ensuing story is, again, involved, many different events happening. Some of these people were beaten by the Americans and considered to be murderers and all kind of things. Some of it is in the book.

WRIGHT: You weren't with that group? You said you were someplace else.

STUHLINGER: It was another group. Beginning in January, even December '44, January '45, we began to dislocate Peenemünde working groups, because we had more and more air raids from the British at nighttime and the Americans by the daytime, so we knew that they knew that there was Peenemünde and something was happening there that had to be destroyed. So we displaced our different working groups from Peenemünde. Mine was displaced to the center of Germany, in Stadtilm in Thuringia. Are you familiar with Germany? The city of Weimar, that's where I was placed with my little group. It's also described in here. I was overrun, my town where I was, it was overrun by the Allied troops in May '45. That was when I was contacted by the Alsos [phonetic] group. You had that question in here.

WRIGHT: Would you like to talk some about the action group?

STUHLINGER: My little group was in the little town of Stadtilm, but toward the end of the war, nothing functioned anymore. No mail, no way of communicating, of traveling. Everybody was just sitting there and hoping to survive somehow. So a number of my co-workers in my group just left. They said, "I have a wife and children in the west, and I don't know how they are doing. I go now and I will try to find them." There was, of course, no way of traveling in a regular way—no trains, no airplanes, not to think of, of course. So one had to bicycle or one could hitch a ride with some of the Army vehicles. It took days to cover a few hundred kilometers. So, many of my people had left and there were very few of them were still in Stadtilm.

One day the allied troops arrived. The tanks came, and we could hear the shooting from a distance. Then there was one group of SS soldiers. They were just roaming the country and shooting where they thought they would find an enemy. It was very crazy. Anyway, the Americans shot back then against the SS groups, so it took about three days of bombardment. Even before finally the Allies came in, the tanks came in. And when the

tanks approached, we people in Stadilm went into the basements of the houses to be protected against the bombs and grenades.

I was, too, in one of the cellars in a house with a number of women and children and old men. Men of my age were all drafted, of course, and were soldiers somewhere. Then after some time, all of a sudden the shooting stopped, and then somebody opened the door up there and yelled down, "Come forth with your hands up," in German, broken German. I was the only one who spoke a little English down there, the only middle-aged man, so I went up like that, the stairs, and said, "There are some people down there."

The man said, "Are there any weapons down there?"

"No weapons. We have no weapons."

"Are there any soldiers?"

"No, I am the only one, and I am a civilian."

Then he said, "Let them come up. Have them come up," and they came up, all of them like that, children and women and old men. The Americans were satisfied with realizing that there were no hand grenades and no machine guns and no fighting spirit and nothing like that.

So we were coming out, and we gathered in the marketplace of the little town, just standing around. In came the tanks. Then one of the first tanks came in, and the lid opened. Out came civilians, not soldiers. It was quite strange. One of the civilians came out and he had a list. He talked to one of the people and said, "There is supposedly a man here by the name of Ernst Stuhlinger. Where is he?"

And the fellow said, "Here he is." I was standing right there.

Then the man said, "Are you this man?"

I said, "Yes."

Then he said, "What is your background? What did you do? Why are you here?" And he had a list. I told him what I was doing and why I was here, and he looked up, and I

realized he knew all of it exactly, but he wanted to know whether I would speak the truth, and I did. So they were relatively nice and friendly.

The man said, "Now, stay here in town. You can stay here. You are free to move around here, but don't leave the town. I will come back in a few weeks and will contact you again, so don't leave the town."

That group of civilians belonged to Alsos. I don't know whether you are familiar with it. You have a question in here. Alsos is a Greek word. It means "grove," a little forest. It was a cover name. There was a gentleman, a general by the name of Leslie [R.] Groves, and Leslie Groves was a high-ranking officer, general in the American Army. He had the order to organize a search in Germany for scientists and engineers that might be of interest for America. In order to cover up the situation, his name, Leslie Groves, was translated into Greek, which means Alsos. So it was the Alsos group. [Laughter] Isn't that interesting?

WRIGHT: That's wonderful.

STUHLINGER: Well, anyway, I stayed in that little town, and a few weeks later the captain came back and said, "I have to ask you to leave that place, and you have to go west, and you have to be across that borderline by midnight tonight." He said, "I cannot tell you why, but you probably will know by yourself." And I sure knew, it was because that whole territory had been promised to the Russians, so the Russians were allowed to move in without fighting, without any effort on their own, but just given to them. [British Prime Minister Winston L. S.] Churchill and [U.S. President Franklin D.] Roosevelt gave it to them in the Yalta Conference.

So the Russians came in, and I left the town to move west, as I had been told. The officer said, "Take all of your instruments with you, all your technical stuff."

I said, "Well, how can I do that? I have only an old bicycle. I cannot do that."

And he said, "Well, you have that car." I was at that time kind of an assistant to the mayor because I talked a little English and also a little French with the French troops there. He also had a car left because he was mayor for a number of surrounding villages to which he had to go, and I was his driver and drove him around to the little villages. Then the officer said, "Well, you have that car."

"That is not my car. It's the mayor's car."

And he said, "Well, from tomorrow morning on, he doesn't need a car anymore, so take it."

So I took the car. There were far more instruments to take with me, but I had one of my co-workers and friends still there also. His name was Ferdinand Ruhle. He's no longer alive. He was in the same situation that I was. He wanted to go west because his family was in the west.

I said, "We have just this one little car which you just, so to speak, gave me, but it's not enough."

He said, "I have another truck in another village, and you take that truck also, and I'll organize it for you." Then he said, "Your friend, [Ruhle], he can drive one car and you can drive the other one, so you put all your instruments on it." You see there was a lot of friendly cooperation between the Americans and us.

My friend, Ruhle had no license and he could not drive a car, so I had to teach him how to drive an automobile in about an hour's time. [Laughter] So I taught him, and then we went to the other village and we got that truck. It was a huge diesel truck, six wheels and so on, a huge thing. I knew how to drive it because I had been trained as a driver with the Army for big trucks, so I knew how to drive it. And I taught my friend how to drive the truck within about half an hour or so. Then we had two cars.

Then there were still a few people left from my group in that little town, and also another group that happened to be there by coincidence, the nuclear energy people whom I

had known from my early times in Berlin, and they were there also. There were a few of them left, and I had contact with them. I also knew them from earlier times. They were there among other people, they had also left, most of them.

But there were two young ladies left there. One was a scientist and the other one was a secretary. The officer who contacted me, he realized that. He said, "What happens with these ladies?"

I said, "Well, they have no way to go."

He said, "Can you take them with you?" [Laughter] "I would hate to see them in Russian hands."

I said, "Well, sure." So I took the two young ladies in my car. It was filled up completely with instruments, two little places for the two girls, and the other car Ferdinand Ruhle. We drove. The same evening we left town and arrived at the border before midnight. It was a rather adventurous trip home. I needed gasoline, you know, and I could only get it from American occupation or military places. But it worked out. I succeeded, came home to my parents. I lived in the west, near Stuttgart. They had not heard of me for three months, didn't know whether I was alive, what I did or where I was. And all of a sudden I was there with two young ladies. [Laughter]

WRIGHT: That must be a story to tell. Before you get to that, let us stop for just a minute and let me change the tapes, and then we'll continue.

STUHLINGER: Okay.

WRIGHT: You were telling us about arriving to your parents' home and they hadn't seen you in three months.

STUHLINGER: Not heard of me.

WRIGHT: Not heard of me.

STUHLINGER: No mail, of course, at that time.

WRIGHT: And now you have a truckful of instruments and two young ladies. I bet their expressions were very glad to see you. Where did your adventure take you from there? Were you with your parents very long, or did you move on?

STUHLINGER: On the 21st of June, I remember, I arrived in Tübingen. I went back to my university. I went back to the university in Tübingen, and they were very kind and nice and let me continue to work, resume my work there, and even gave me a little income there.

I hoped and expected that I would just stay at the university and find a new existence, a new life, but then in October of that year, 1945, still '45, shortly after the war in Japan had ended, there came another officer to my home in Tübingen and said, "I would like to invite you to come to America. Would you like to come?"

And I said, "For heaven sake, what should I be doing there?"

And he said, "Well, you will be doing what the American Government thinks is the best for you to do for America. We want you to come [on] over. You have been a member of those operations here, and you will be very valuable for us. We would like to invite you."

I said, "Well, what are the conditions?"

And he said, "Well, von Braun is already there, and he is gathering his old co-workers. We have a list here of 127. You are one of them. We want to invite you to come on over."

And I said, "Well, can I think it over?"

And he said, "Of course you can. By all means. It's your free decision. I'll come back in a week from now, and then you tell me."

And I discussed it with my parents and friends, and after a week the officer came back and said, "How did you decide?"

I said, "Yes, I would like to accept it and to come."

And he said, "Okay. Fine. We'll go through the procedures. I will come back on January third in 1946, pick you up, take you to Munich [Germany], and from Munich to Le Havre in France, and from Le Havre to New York."

And sure enough, on January the third, he came with an open jeep. It was a strong winter, [there was a blizzard, it was] awfully cold in the open jeep, and we traveled through this snowstorm to Munich. About three days later, I boarded the train to Paris [France], and then to Le Havre. In Le Havre, again after a few days, a number of us collected together, former Peenemünde people, we boarded a Victory ship and came over by boat to New York, landed there in early February.

Went first to Fort Hunt, near Washington [DC], south of Washington. Fort Hunt, I was there about two years ago and looked at it. It's a park now, a public park, very nicely done, with entertainment facilities for people. We stayed there for about three weeks, and then after that time we boarded another train to El Paso in Texas. Then my Texas time began, four and a half years.

WRIGHT: Quite a change of scenery from New York to El Paso.

STUHLINGER: It sure was.

WRIGHT: Had you ever thought about going to America prior to the war?

STUHLINGER: Yes, yes, very much so. That is something that may not be known too well to many Americans, but America, for us young Germans, was always a land of our dreams. America was, as we called it, the land of unlimited opportunities. It was a beautiful countryside. It was a land of freedom, great freedom. For a German to go to America would be very different from, a change from Germany to, say, France or England or Italy or Russia or something like that. During the last 300 years, 7 million Germans emigrated from Germany and settled and found a new home in this country. I heard a statistic the other day that said that 50 million Americans have Germans [only] two or three generations back in their ancestry, so there was always a great flow of population from Germany to America.

For us young Germans to go to America would not be simply a change of country; I would say it was a step in evolution, almost. [Laughter] I have been here now for over fifty years, and I never felt homesick for one moment. Neither did my wife, by the way.

WRIGHT: When you came, you had a place to go and a task for the future, but yet you did not know what that task was.

STUHLINGER: Right. Right.

WRIGHT: Did you find that peculiar, that you did not know what you'd be doing?

STUHLINGER: It was so. It was a fact. We did not know what would happen. When we came here first, we thought that we may be here for three months or six months, and we would be sent back home again, so it was an open-ended future, so to speak. And only at a later time we realized that the Americans planned to keep us for a longer time. Then after we had come to Huntsville, of course, we realized that we probably may stay here forever.

We were allowed to take our first papers for immigration. The process took quite a time, because we were all investigated very, very thoroughly for all the things we did and did not do in Germany back in the old country, but we were all cleared, so to speak, and found not to be criminals, neither war criminals nor other criminals, and so we were accepted at our face value, I would say. We found many very good friends here in this country.

WRIGHT: While you were here beginning your new life, some of your former co-workers were in Russia, beginning a new life that they didn't know all that they would be doing. Did you have any idea of what had happened to them?

STUHLINGER: I do know now, because there were a few books written about their fates. So I know roughly what happened to them. It was totally different from what happened to us here. They were kept within their own group all the time. They had almost no opportunity to learn Russian and to mix with the population and to grow into Russia. They were kept isolated in Gorodomlya. That was an island in the Volga, north of Moscow. They were not allowed to know, really, what they were working on. They were given tasks to work out like guidance systems or ballistic theory and things like that, but they were never made part of a project, so to speak. They did not know what the work was they were working on.

They were always kept in isolation as a group that was not allowed to integrate and to really become a part of the country. They were always very eager to return home to Germany, all of them, up to the very end. It was different here. We happily accepted the new home and to grow into the society here.

WRIGHT: When most Americans heard about Sputnik, to them it was the Russians putting up this satellite, but for you it was people that you had known had developed that. Could you share with us your feelings when you heard that Sputnik had launched?

STUHLINGER: Some of us had known for several years that the Russians were working on a satellite project. Not everybody in this country knew about it, and by far not everybody believed it. Some of us, including myself, we knew, because I had contact with a number of the Russian scientists. I met them in congresses and some of them were even friends of mine. The chief scientist of the Russian program was Professor [Leonid] Sedov, we were friends and we exchanged thoughts. I knew that the Russians were close to launch a satellite. It's in the book, again. You can read it up in there. So I was not really surprised when I heard about the news, because I had really felt that it was only a matter of days or weeks, at most, before they would send it up. My anticipation was fully fulfilled and verified. Not everybody had the same premonition and same expectation.

Anyway, by the way, I wrote a paper last year in memory of Sputnik. If you are interested, I would be glad to give you a copy of it. I don't know whether you could work a written copy into your program.

WRIGHT: Yes, we'd like to have that.

STUHLINGER: I'll give you a copy of it.

WRIGHT: So many Americans wanted to have America in space first, but, of course, Russia accomplished that. Did you feel disappointed that America did not reach that?

STUHLINGER: Yes, because we could have done it. "We," I mean the von Braun team. We could have put up a satellite in [19]'56 if we had been given the green light for the plans and the hardware to do it. The decision in Washington [DC] was different, that it should not be

us to launch the first satellite; it should be the Vanguard system, you know, the Navy system. And again it's in here.

WRIGHT: Those were the first days of the Redstone rocket, is that correct?

STUHLINGER: Well, it was not the first. As you know, the first Redstone flew in '53, and we could have launched a satellite in '56, three years later, and we did launch it in '58, with a Redstone.

WRIGHT: Could you tell us what your responsibilities were with the Redstone Project? Share some of those times with us, of those days.

STUHLINGER: Von Braun had the idea to launch a satellite. Of course, he had it from his teenage years on. But then our Redstone rocket began to take shape, that was in '52. It was before the first launch. But it took shape and we realized that we will be able to get through with the project and complete it. At that time, von Braun approached me one day and said, "With the Redstone, we could do it."

I said, "Do what?"

He said, "For heaven sake, to launch a satellite, of course."

And so I realized then that von Braun had firm plans from that time on. In fact, the plans he told me in '52 with upper stages, [and all that] you know, was how it was actually done then six years later. So it was on his mind for a long time.

Now, my immediate involvement, besides being very excited about the possibility, my immediate involvement was a little technical. I should go into some technical details. The idea to launch a satellite with a rocket was about the following. One would take a Redstone rocket, put on top of it a cluster of three stages of small solid propellant rockets,

just three in sequence, that would fire in sequence. The Redstone would go up on an almost vertical flight, turn around, and then fall down again. But at the moment of apex, when it was oriented in a horizontal direction, there would be a signal from the ground at the moment when it was just at the apex exactly and was exactly horizontal, at that moment a signal would be given to ignite the first of the three stages. The three stages would fire in quick sequence, about two seconds' burning time each—dit-dit-dit. And they would shoot out, the front part which would be the satellite, and the satellite would then go into orbit.

In about '[5]3 or '[5]4, von Braun told—well, I should first say that von Braun had no permission to go into the satellite project; he did it all, so to speak, in the back of his mind, talking softly to a few of his close co-workers, making plans. But he was not allowed to make a real open official project out of it. But he told me at that time, "You figure out how we can produce that signal to find the right moment of apex and then to shoot out these other rockets." The moment could not be determined ahead of time, because one did not know exactly how fast a rocket would be, how high it would be at cutoff, how fast it would be at cutoff, and how long it would take to be up there. So we had to measure this while it was going up on its ascent flight.

One would have to determine the position and the velocity. That could be done by several different methods. About three methods we considered. The one was by measuring the acceleration and then calculating from the acceleration and the velocity. The other one would be by Doppler, by Doppler signal. And the third would be radar signal.

Von Braun told me, "Now you figure out how to do it, and you build that system." We called it an apex predictor. I did that and built it, but I was not allowed to do it as an official project utilizing all of our facilities, so I had to do it, so to speak, very quietly and to build that system in my garage at home. I had a few good friends who could help me in doing that. For example, I needed, among other things, one very precise spindle which would be kind of a clock, linear clockwork, to measure the time. A precision spindle was

made by one of my friends in his shop. He said “I will just do it.” But we could not talk openly about it. It was a very strange situation. But anyway, the apex predictor was ready by the time it was needed, and it worked perfectly.

WRIGHT: That's great for a garage project. [Laughter]

STUHLINGER: And then another involvement was the following, again at an early time. It was about in 1953, von Braun came again to me and said, "Well, we have our satellite plans. We begin to think of then now, and they seem to fall in place, but we should have scientists aboard. It should not be just a mission to put some inert sphere or bubble," as President [Dwight D.] Eisenhower put it, inert bubble into orbit. "We have a real scientific discovery of measurement connected with it." Then he said, "You know so many scientists here in the country, why don't you contact one and see whether we can get him involved."

I was very happy about this, because I happened to know one of the scientists in the country. That was again a very strange story. It was Dr. [James A.] Van Allen. You may know him from the Van Allen Belt, in Iowa City. He was a cosmic ray researcher. I had worked on cosmic rays also for my thesis back in 1935. At the time I read a paper by one Van Allen in this country, who had done some similar observations of cosmic rays as I had done, so I knew his name.

Then I happened to meet the same Van Allen in person early in [19]'46 when we had our old V-2s in White Sands [New Mexico] and launched them in White Sands for scientific purposes and for testing purposes, training purposes. I met Van Allen at that time, and we had some nice contact and exchanged our views about cosmic ray counts and things like that.

So when von Braun told me, "You'd better look for a scientist," I said, "Okay. I happen to know one and I will contact him."

So I visited Van Allen in 1954, and that's again a story in here. I established contact with him again. It was a very nice meeting, and I told him all about what we are going to do with our satellite project, and that we would have room in the satellite for a cosmic ray counter, and wouldn't he like to build one and put it on? [Laughter]

A very strange situation again here. Van Allen listened to me. When I told him that, he was at Princeton [University] at that time, on sabbatical. I met him at home, and he was sitting on his sofa. He was a big pipe smoker. He took his pipe and he surrounded him completely with a cloud of smoke. [Laughter] I told him, and then I was finished with my talk, and I thought he must be excited with the prospect of having a cosmic ray counter up at that altitude to measure cosmic rays. But, instead, he said, "Oh, interesting. Keep me posted on your progress." Nothing else.

I was quite disappointed. I thought, "For heaven sake, I have blown the whole story. I am sorry."

So I went home and was rather disappointed, but I kept him informed of our progress. Some time later I contacted him again and said, "Well, Dr. Van Allen, we are now so and so. We could fly your instrument, it could weigh so many pounds, and we have an antenna. We could really accommodate it. Wouldn't you like to do that?"

Van Allen at that time was also a member of the Vanguard group. You know the Vanguard Project. He had prepared an instrument for Vanguard. We encouraged him to prepare his instrument so that he could also fly on our satellite. Very quietly and without saying much, he did it and prepared it. Later on, he said, "Well, I prepared my instrument so it could fly on Vanguard or on the Explorer satellite, just in case." [Laughter] I don't know whether you know him. He's a very fine person and a recluse, very quiet and doesn't talk too much.

Anyway, he did prepare it, and when the time came, he had his instrument ready. The JPL people helped him a little bit with the transmitter system. We put it on, and he discovered the Van Allen Belt with our flight.

WRIGHT: That was double rewarding for you.

STUHLINGER: It was. It was. It was real nice.

WRIGHT: Where did you go from there in your progress? You now had the Explorer. It was doing well. What was your next project?

STUHLINGER: After Explorer, we had a few more satellites, larger and bigger. Some of them were launched with Redstones in the same way, and others were launched with our next missile. It was a Jupiter missile. Then that was, in '59, '60, by the time we were already deeply involved in the lunar project. In fact, von Braun began around '58 with a hardware program, developing hardware, particularly the big F1 engines.

In '61, you may remember, President Kennedy opened, so to speak, the door for the big project, so everybody here worked in the Apollo Program. Later on there came the Skylab Program. In '73, Skylab was launched. Hubble was launched a little later, and then we went into the Shuttle Program. I retired in '76 from NASA, but the work went on. The big projects under way now, Space Station particularly, Shuttle is still flying. They're just developing a new engine. You may have heard of that a little bit, X-34 and X-33 and X-38. So they are going on with propulsion systems and new rocket and spacecraft systems.

WRIGHT: NASA continues strongly after forty years, and you were here in Huntsville when it first was created. Did you see a change in how operations were occurring once you became officially a part of NASA?

STUHLINGER: Yes. Of course, we did before that. We were members of the Army. The Army's main purpose in life is, of course, to develop weapons and be prepared for military conflict. So we built the Redstone and the Jupiter and the Pershing for the Army. When we began thinking and even cutting hardware for the Saturn-Apollo Program, even while we were with the Army in '58, we came to the NASA in '60. The changeover from the Army to NASA meant, of course, primarily that we would no longer be involved in military projects. For von Braun it was a great relief, and he said, "The greatest impact of that change is from now on we are allowed to do only scientific and exploration projects and do not have to build weapons anymore." It was for him a great relief and a great event.

WRIGHT: It took many years, but he was able to finally have that behind him.

STUHLINGER: On the other hand, our relationship with the Army was very positive and pleasant. We had real nice relationships. Even today I have a few good friends in town who were officers at that time while we were with the Army, and we were on very good terms mutually. You know, even if a person is very peacefully oriented in his own constitution, one cannot deny that the military effort is here with us to stay and cannot be denied and cannot be talked away.

Also one must not overlook the fact that every and any great development, technical development, in the past 3 million years, had also military implications. All the great things were used also militarily.

WRIGHT: Would you share with us about the Jupiter, since you're talking about military days? That was part of the Army project that you worked on.

STUHLINGER: After we had the Redstone going, that was in the early fifties, we received the assignment from the Army again to develop a larger vehicle. The Redstone was a rocket covering about up to 400 miles, 300, 400 miles, and the Army wanted now a missile that could cover 1,500 miles and could carry nuclear warheads. So we developed the Jupiter. It began in '53, and I think the first launching was in '58.

As usual, when we developed the [V-2 and the] Redstone and the Jupiter, almost regularly the first two flights were failures, and the third flight was a success. I think it was the same on the three military systems which we developed. The Jupiter was a well-working vehicle that was deployed also in Europe as a potential weapon.

Very interestingly, besides the V-2 in Germany, none of the big rockets, including the Russian rockets, was ever used in anger, so to speak. Never. Not the Titan, not the Atlas, not the Pershing, not the big Russian military rockets. Smaller rockets, yes, like the [Russian] Scuds and some of our missiles now used in Kosovo, particularly long-range cruise missiles. But none of the big rockets was used in war action.

On the other hand, I am convinced that the existence of the big rockets, the intercontinental rockets with the nuclear warheads, just their existence is the reason why we did not have a third world war. I think if we had not had these big rockets, with their tremendous destructive power and their intercontinental capabilities, if we had not had these to threaten each other from both sides, if we had not had them, I do not believe that a third world war could have been avoided. So that's one way how to look at the development of the big rockets.

WRIGHT: So much of your life has been part of that involvement, and many of your members that you came with from Germany stayed together all those years.

STUHLINGER: Yes, yes.

WRIGHT: Why did you choose to do that? I understand that many of you had chances to move on, but you wanted to stay.

STUHLINGER: The single reason is von Braun's personality. He was a totally uncommon person, very magnetic person. I could talk about him for hours. [Laughter] Much of it is in the book. But he had a way to meet with people and converse with people and be close to them which was totally unusual and different from other situations. For his co-workers, it was a privilege to work with him and to work for him. It was immediately a feeling of great closeness, and you felt not in his grip, but under his influence, under his human powers, so to speak, human magnetism, or whatever you may like to call it.

To characterize is way of meeting other people, we had one member of the headquarters staff during Apollo times, that was General [Samuel C.] Phillips. He was a very capable person. I had a lot of admiration for him. One time there was a meeting in Washington [DC], a big, big social meeting where the wives were invited, and Mrs. Phillips was invited there, and von Braun was also invited. Von Braun and Mrs. Phillips happened to sit together. It was the first time they ever met. General Phillips told us later on, his wife told him all about sitting next to von Braun, and she said, "I had the impression that for the whole day von Braun had done nothing else but look forward to the moment when he was sitting by me and talking with me."

WRIGHT: How nice. Do you remember the first time that you met von Braun?

STUHLINGER: Yes, yes. It's also in here.

WRIGHT: Could you briefly tell us what it was like?

STUHLINGER: I could. I was working in the laboratory where we developed guidance and control equipment, accelerometers. The head of the laboratory was a person who also had come back from the Army, from the front as a soldier. He was also a Ph.D. and he was head of our laboratory. We worked in the lab, and I did my testing and developing there. Many people came in and got something and discussed something and took something out.

One day there came a young man, and he was very young, looked like eighteen or nineteen. He was actually twenty-five at the time. He came in and immediately, my boss, Walter Schwidetzki was a different person. Walter was very alert, very excited, and talked to the young man far, far more intensely and gave him more attention than to anybody else that came in. The young man said, "How are you doing today?"

And Schwidetzki told him, "We're working on this and this."

And von Braun said, "Did you do the testing?" Well, I didn't know it was von Braun at the moment, the young man. He said, "Did you do the testing of your accelerometer yesterday?"

Schwidetzki said, "Yes, we put it on the shake table and shook it and saw that it worked."

And the man said, "What did you find?"

And Schwidetzki said, "Well, we found that there were a few resonance frequencies where the amplitudes were a little bit too large, but we can remedy that somehow."

Then the young man said, "What did you shake it with? Did you have just a sine-wave excitation?" Can you follow this technique in terms? Do you know roughly what it means?

WRIGHT: Yes.

STUHLINGER: And Schwidetzki said, "Yes, we have a shake table which makes sine waves."

And then von Braun said, "Well, that's not a real replication of the true situation. Couldn't you do the following? Couldn't you take one of your magnetic recorders?" We had magnetic wire recorders at that time, an old-fashioned instrument. The young man said, "Couldn't you take a microphone and take the noise of a real rocket engine while it's burning on the test stand, put it on your recorder, and then take that and put it through an amplifier and into your shake table? Then you can shake the table with the real frequencies and a mixture of frequencies which occurs during a firing test of the engine."

Schwidetzki said, "Yes, we sure can do that. We'll do it."

And the young man said, "Okay, do it and please keep me posted on what comes out of it." Then he left again, said, "Well, good luck," and left.

I was surprised. I immediately was also somehow touched and struck, and I said, "For heaven sake, who was that?"

And Schwidetzki said, "Well, that was Professor von Braun."

I said, "Really? But he looks so young."

"He is. He's twenty-five years old."

Then I said, "And he is the boss of this whole huge Peenemünde and the director?"

And Schwidetzki said, "Yes. He was a director wherever he was. He's always a director and on top of everything."

And that was my first impression. Then I have worked for him for thirty-three years. We met very frequently, not only in work, but also personally and privately. For example, our families went to the river on outings over the weekend. He had three children. We had three children. We went to the South Pole together for a full week, a very nice and eventful stay on Antarctica. We did flying together, motor flying, soaring. He was a great believer in flying. We did scuba diving together at a number of places. We were in very much contact together.

WRIGHT: He seemed to have had an impact on many lives.

STUHLINGER: He sure did. He sure did. He was a very exceptional person.

WRIGHT: And you have as well. Many people who have gone to space, have gone to space thanks to your know-how and your determination to do that.

STUHLINGER: Probably.

WRIGHT: Have you had many conversations with those who have traveled to places that you will not go, that you have helped propel to do that?

STUHLINGER: Well, I talked to many of the astronauts, of course. With some of them, I became good friends. Like Owen [K.] Garriott. I knew a number of them. Buzz [Edwin E.] Aldrin [Jr.]. Neil [A.] Armstrong is very secluded, a recluse. You cannot get close to him. But others, we did. And this young man here, Don [Donald A.] Thomas, do you know him? No? He's in Houston. He's a very close friend of ours. He has been here a few times, and we write letters to each other. He got a baby the other day and my wife made a little thing

for him and so on. So we are close to him. Alan [B.] Shepard [Jr.] I knew quite well. John [H.] Glenn [Jr.] I knew quite well personally.

WRIGHT: Were they able to relate to you how it was to be in space, riding your rocket?

STUHLINGER: Yes, we talked about that, of course. It's one experience one cannot have without doing it, of course, but on the other hand, the persons who do it, they are humans like I am, like you are, and you can share with them their experiences and talk about it. On the other hand, it's an unusual environment to be under weightlessness.

I was in one of these parabolic flights, you know, where you have twenty seconds of weightlessness. They fly from Houston, and I was there, too, and enjoyed it very much.

WRIGHT: I have to take that wasn't recently. Was that a while—

STUHLINGER: It was, I would say, thirty years ago.

WRIGHT: A few decades ago.

STUHLINGER: A few decades ago.

WRIGHT: And you continue watching all of the accomplishments of NASA?

STUHLINGER: I try to. It's too much to do all of it. I have mountains of journals, you know, which come in almost every day. There's a lot of journals. I cannot afford to read all of them. But I follow. In broad terms I follow what is happening.

WRIGHT: Your life has led you to be a scientist and, of course, a survivor, an author, a lecturer, instructor. Is there one area that you have enjoyed more than the other?

STUHLINGER: Well, there are a number of things I enjoyed. I enjoyed having a family. We have three children. I'm still in very close contact with all of them, and grandchildren. Of course, the most impressive part of my life, besides my own family, of course, was to be with von Braun and to be in his close vicinity and under his influence.

WRIGHT: Do you feel you have one or several significant accomplishments, that if you had to pick a few, you're very, very glad you were there at that time to be able to fulfill those?

STUHLINGER: Well, there are a few things. For example, what I mentioned earlier, the apex predictor for the first satellite. It was a small development which did not amount to a large project, but it contained a lot of thinking and planning and developing, and it worked. It worked. That was an accomplishment. Then I still hope that one of these days we will have a manned mission with electric propulsion going to Mars. That has been one of my favorite study projects.

WRIGHT: And, of course, those thirty-eight people who signed your poster for space would also like to see that.

STUHLINGER: Oh, yes. Oh, yes.

WRIGHT: This is a history project that will be put on record, that others can use your words to learn from. Is there anything you would like to add at this time that we haven't talked

about, or any issues that you would like to share with us that we haven't had a chance to visit, that you can put down?

STUHLINGER: One of your questions here says, "Were there any people with which you worked that made a significant impact on you personally?" It's at the end of your list. When I read your list, I thought of that, and I would like to answer that question.

There were, of course, very many people whom I met in my life, colleagues and other scientists. I had the good fortune of meeting a number of real important scientists, Lyman Spitzer and Herbert Friedman and Jim Van Allen and so on. But among these people, to answer your question, I would like to mention three persons at first.

The first is, of course, everybody would like to mention his parents first and his own family, but besides that, I would like to mention three others. One is my first boss in physics, my professor. That was Hans Geiger. He is the man who invented the Geiger counter. He was a professor of physics, and he helped me with my theories and took me from Tubingen to Berlin with him when he transferred to Berlin. He was a very impressive person. I learned very much from him also how to like science, how to approach scientific problems. I learned that from him, and how to appreciate what science can do and how it should be handled. It was, for me, a great influence in my life.

The second person is, of course, von Braun. He was a very dominating figure in my whole life, thirty-three years of close work together. I figured out the other day that I was present in about 1,500 meetings which he chaired, technical meetings, some of them also going into questions of how to approach a project, how to get it through, to get it accepted, and how to approach other people to make them understanding and cooperative. He was, of course, a very great influence, a very decided influence.

And the third person I would like to mention who impressed me very much, whom I never met because he died before there was a chance, was General Marshall, George C.

Marshall. He is the one who initiated the Marshall Plan. The Marshall Plan helped Europe and even this country to get into a livable shape and form again after this terrible war. That was a great accomplishment on his part. I think that everybody who was in any way involved, particularly us Germans, we are very grateful to him. We are very proud that our center is named after him—George C. Marshall Center. He was certainly indirectly a great influence in my life also, because it helped my old country to come up to a livable state again after that war.

WRIGHT: Do you have any suggestions for young people for areas that they may go into, that will lead them into such a fulfilling life that you have led?

STUHLINGER: Of course, many things happen in a life which are out of one's own control and you cannot set the switches, so to speak. One has to accept how it's coming. If I should give a recommendation to young people, what they should be doing, I would say choose one field which you like, and try to be as effective, as knowledgeable, and as capable in that field as you possibly can. It should be some field of science or technology or whatever you feel you fit in best, and then try to learn as much as you can in that field. For example, electrical engineering or physics or chemistry or biology or something.

And then I would encourage people who have a liking for exploration and for space matter and then on that basis of thorough knowledge in one field, try to build up now a capability in the framework of the space program. I'm biased, of course, in that respect, but for me the space program is certainly one of the most important human activities of our time.

It's a very simple situation. Our planet is in danger of overpopulation and of overusing and of abusing, environmental problems, problems of overpopulation and the other programs, and they must somehow be solved in the future. I think we can solve these problems only by just learning more and more about our own world, about our planet, about

conditions under which a planet can continue to be habitable and livable. We can hope to learn more about it only by doing research and by trying to learn about it. Our space program will help us very much in that respect.

Our space program helps us to learn more about our Earth by observing it from the outside, things like climate changes, global warming, things like that, and also it gives us insight into the workings of other worlds, like planets—Mars, Venus, Jupiter. And from that knowledge we will also be in a better position to judge our own planet and what we should be doing and what we should not be doing. So I think in this respect, even, just in seeing the necessity to keep our own planet in a livable state, even from that standpoint, it will be very important to do space research and to develop a space program further and further.

WRIGHT: Do you have ideas where you believe the space program should continue?

STUHLINGER: Yes, I have certain ideas. Actually they are very simple. When we look back over the development of the space program over the last fifty or so years, we realize that there are two main avenues which have developed out of the earlier activities. One is commercial uses of space that includes communication satellites, satellite that observe the Earth from outside, observe the climate, the weather, pollution of lakes and rivers. Things like the Internet, for example, which begins to play such an overriding role in our life, all of this I would call commercial and other practical applications, direct applications of space travel capabilities. That is one line.

The other line is pure research. It is simply the quest to know more about our world, about our environment, about things that happen in nature than we have known before. This quest is a very old quest in humans. It has been with humans for the last 3 million years, I would say. Well, the state of civilization today, of knowledge of our own Earth and of nature and of many things, that is only the result of this quest for more knowledge. I think that

should be continued. The space program will be a beautiful way to learn more about our world, our nature, about our environment, and we should follow that.

I would believe – maybe looking forward a little bit too far – but I would like to see that the commercial applications and the practical applications, which would include military applications, should be done by the private sector with government support also, of course, but in their particular line, industry should be very active, doing development by private enterprise, with some support from the government.

The other line, namely pure research, I believe should be done and financed by the government. It should not be expected that private enterprise will do much of that kind of research which does not give immediate returns, financial returns. That is, I believe, where the government should come in. So the government should, for example, I would hope, should finance our next large program, which would be manned travel to Mars. I firmly believe in that. That is something that I believe should be financed by the government. The building of rockets that can launch satellites for pure applications, like communication satellites and spy satellites and things like that, I believe that should be left to private enterprise, to industry.

That's a simplified outlook, but that's about the result of fifty years' involvement in the space program. [Laughter]

WRIGHT: That's many years of experience and a very good suggestion on where we need to go next. Your life has certainly been an inspiration to me. Have you watched your students that you have had, and younger co-workers—

STUHLINGER: Some of them, yes.

WRIGHT: I know it's rewarding to see them follow in your footsteps and continue on with the NASA program as well. I want to thank you for spending time with us this morning.

STUHLINGER: You are welcome. I hope you can use it.

WRIGHT: Every bit of it is very worthwhile.

STUHLINGER: Thank you.

WRIGHT: I know that many people will look forward to learning these lessons that come directly from you. Thank you again.

STUHLINGER: Thank you very much.

[End of interview]