ORAL HISTORY 2 TRANSCRIPT

OWEN G. MORRIS
INTERVIEWED BY SUMMER CHICK BERGEN
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BERGEN: Today is June 30, 1999. This oral history interview with Owen Morris is being conducted in Houston, Texas, as part of the Johnson Space Center Oral History Project. The interviewer is Summer Chick Bergen, assisted by Sasha Tarrant and Tim Farrell.

Thank you so much for letting us speak with you again today.

MORRIS: You're quite welcome.

BERGEN: Last time we talked about your early career up through Apollo. I wanted to give you the opportunity to tell us anything that maybe we didn't get to include last time that you remember.

MORRIS: Yes, a couple of things that I remember. Apollo was really motivating to people all across the country and, as a matter of fact, all throughout the world. Frequently when people learned that the equipment they were working on was going to the Moon or was part of the Apollo Program, they would take extra special efforts to make sure that they did that exactly right. And that was a large part, I think, of what got us there as well as we did.

However, a couple of times it worked to our disadvantage to a certain degree. I can remember one time very early in the program, the [North American] Rockwell Corporation was putting together the first command module that had significant electrical systems inside. They were making the wiring harnesses that went inside the command module, and as they tried to install them, they found that the pins, the ends of the wires where the pins were going in as connectors, were breaking off. They couldn't find any reason for it. They sent the wire

to the laboratory, they sent the pins to the laboratory, they sent the crimping tools to the laboratory, and checked them all out and they were working just fine. They would make crimps in the laboratory and they would pull test, and it worked just fine.

They then started tracking it down to which operator did which crimp, and they found one lady out there who had evidently extremely strong hands, and she knew that she was working on the Apollo Program, so when she crimped, she crimped extremely hard, and she could actually crimp hard enough to deform the tool and squeeze the wires to where they were almost broken. [Laughter] She was just trying to do her job a little bit better than normal, but actually she was causing us a lot of trouble. For her, they put a spatial stop on the tool that she couldn't crimp it any harder. She was not reprimanded, obviously, because she was really trying to do a better job than normal.

Another one that was later in the program, on the lunar module [LM] on Apollo 11, just before the flight, a couple of months before the flight, we started seeing crystals in the coolant loop, the water glycol loop that cooled the electronics on the lunar module. We couldn't find out where they were coming from. We had many test rigs running, and at that time for three or four years with the same metallic systems, the same coolant, and working just fine. And here all of a sudden we were—well, we called it a crystal farm because just over a day or two we would just have a large number of crystals growing there.

Again, we called people in from all over everywhere to look at the metals, to look at the solution, to look at the equipment they were using, the ground support equipment, trying to find out what was causing the problem. They finally traced it to the supplier for the glycol that went into the coolant loop. He had been the same supplier that had been supplying the stuff for a long time, but he found out that the glycol that was going into the lunar module and it was part of the Apollo Program, so he was going to do a little bit better. He went back and read the specification very carefully and found out that he was supposed to be furnishing pure glycol. All the glycol he had been furnishing to other customers and to NASA before

that contained an inhibitor which prevented corrosion. It also prevented the formation of the crystals. But this specification said pure glycol and it was going to the Moon, so he left the inhibitor out, gave us pure glycol, and that's the reason we started growing crystals all over the place.

So the fix to that problem was to go back to the commercial-grade glycol, put it back in the lunar module, and we had the rest of the program and had no trouble at all with it. But just a couple of cases. There are really examples of many, many people trying to do a bit more than normal, and every once in a while it backfired. Looking back on it, it's a little bit humorous. But the people were really trying to do their job just a little bit better.

BERGEN: It shows all the support that was there for the Apollo Program.

MORRIS: Yes, it was there all over the world, really. After the fire in the command module [CM], we needed, of course, a lot of paper to go on the flights—procedures, equipment handbooks, and that kind of thing—and we wanted fireproof paper. A company—I've forgotten now, it was either France or Sweden said, "Yes, we can make paper that is fire-resistant. It really isn't fireproof, but it's very difficult to burn." So they started making that paper especially for the Apollo Program, and we printed all the onboard documents on that paper. Just all over the world, people were trying to help.

BERGEN: And there are so many different things it took to put everything together and make that accomplishment happen.

MORRIS: Yes. Yes, all kinds of things.

BERGEN: As the Apollo Program ended, NASA shifted into the Shuttle Program, although there was, of course, the Skylab and Apollo-Soyuz, but a large number of people, you included, shifted into the Shuttle Program.

MORRIS: Yes.

BERGEN: How did that environment of working on the Shuttle differ from the environment of working on a program like Apollo?

MORRIS: Not a whole lot different. The same NASA centers were involved, here [Johnson Space Center (JSC)] in Houston [Texas], Marshall Space Flight Center [MSFC] in Huntsville [Alabama], Kennedy [Space Center (KSC)] at the Cape [Florida], were again the main players in the Shuttle Program, and they had been the same players in the Apollo Program. So the environment was not really particularly different.

Of course, the job was different. The Shuttle was a different kind of a vehicle that was designed to be basically a transportation system that would operate as close to an airline kind of a thing as it could, whereas the Apollo was one shot. You used all the equipment up on one flight and then you built a whole new set of equipment. So the technical tasks were different, but the environment was not materially different.

BERGEN: As an aeronautics engineer, how did you feel about starting work on this new type of vehicle?

MORRIS: Well, I felt a bit more comfortable in that there was aerodynamics involved, finally, and I knew a little bit about aerodynamics, so I felt comfortable working in that technical field again. But I was initially deputy project manager for the lunar module, and, of course,

my purview encompassed all the systems on board. But it was fun playing with the aerodynamics again and doing that kind of a thing.

BERGEN: As you said, you were deputy manager for the Orbiter Projects. What exactly did your job entail?

MORRIS: Well, I was working with Aaron Cohen, who was manager of the Orbiter Project at that time. All the way through he was. He was responsible for all aspects of the Orbiter, and I was his deputy. We worked together. We had worked together during the Apollo Program for many years, so we were very comfortable working with each other. Both of us would do whatever was necessary to get the Orbiter Program going.

BERGEN: What did that require at this time, which was early seventies? What issues were you dealing with initially?

MORRIS: Probably the biggest issue we had at that point in time was weight, again. Orbiter, the weight estimates were increasing as the design started to get detailed. The rockets on the launch elements were either sized or almost sized so that said how much weight you could lift into orbit. As the Orbiter weight grew and approached that limit and then would exceed it, obviously we had a problem. So we had to then go back and reduce the weight of the Orbiter, and the launch elements saw what they could do to help launch a little bit more weight. But that was probably the primary problem.

Technically the thermal protection system [TPS], the tiles that we were using for the thermal protection system were new state-of-the-art development, and there was a lot of work, a lot of concern about them, a lot to be learned about those tiles. So that was pretty heavy work at that point in time. Those were probably the two biggest areas. Most of the

other technical aspects were reasonably well in hand, and it was a matter of doing the design work, but not really going out and doing research and development.

BERGEN: A lot of the design depended upon agreements with needs of the Air Force. Did you interact any with the Air Force in that relationship?

MORRIS: Not too much at the point in time that I was working on the Orbiter. Later on when I was in charge of systems integration, I had very detailed interaction with the Air Force at that point in time.

BERGEN: Could you tell us about that relationship between NASA and the Air Force and how that affected the Space Shuttle?

MORRIS: Yes. I guess I started working with the Orbiter in early 1972, and in the fall of 1972 I was asked to take over the integration program for the total Shuttle Program, not just the Orbiter. The job there was to integrate the Orbiter, the launch elements, the people at KSC, the procedures at KSC, and the users, and put all of that together to make the best total vehicle that we could make. That was basically the job.

Part of that job was working with the Air Force. The Air Force had a specification for the attributes they wanted for the Shuttle, and they were somewhat different than NASA. One of the big things the Air Force wanted was a very high cross-range capability. By cross-range I mean as the vehicle reenters the earth's atmosphere, it could turn and go sideways and land at a place that was well off the orbital track. As I remember, they wanted like a 1,500-mile cross-range, which did a lot to dictate the external configuration of the Orbiter, and got into the aerodynamics very detailed. There was very long discussions about that cross-range capability.

The other big thing we had going with the Air Force was the payload capability, how much payload could you take up and how much payload could you bring down. We worked out that specification over a period, a fairly long period of time, actually. It was maybe a year and a half, two years working on that to get both sides feeling comfortable they had something that they could work with all right.

The Air Force also wanted a very rapid launch capability so they could react to a changing military environment in a very expeditious manner. We incorporated the things we could to help them satisfy that part of their requirement. Through most of the program prior to the first launch, actually, the Air Force intended to set up a launch capability on the West Coast, at Vandenberg Air Force Base [California]. The NASA people in my group worked with them to help them design that launch facility to be compatible with what was going on at the Kennedy Space Center, for NASA to use as much of the same hardware, the same equipment, same procedures as we could for commonality and economy.

Those were probably the three major areas that we worked with the Air Force in at that time. The Air Force had an office here in Houston that varied in size. It probably was two dozen to three dozen people most of the time, and we were working intimately with them on a day-to-day basis.

BERGEN: As systems integration manager, you mentioned that you dealt with many different groups of people in different areas. What was your biggest challenge in that position?

MORRIS: People. [Laughter] Of course, all the people involved had their own responsibilities for their part of the program, and trying to get the overall program put together in the most efficient manner involved people frequently giving up part of their capability, part of their prerogative, to help a different part of the program, solve a problem,

and do it in a manner that was better for everyone except them. And that's a little difficult to convince people to do that.

So, working with people, working with organizations, and getting them to work together in a harmonious manner was probably the most difficult part of that. There were a lot of technical problems, a lot of technical issues, but getting the people working together, and I think we were quite successful in doing that, actually. It was a little bit rough early in the program as we first set up the integration office, but in a fairly short period of time we got people understanding the real requirements if we were going to have a Shuttle, that we had to work together and everybody had to give up a little bit every once in a while to help the overall program.

Within a year or so, we were working, I think, in a fairly harmonious manner. A lot of friendships were developed that are still there, as a matter of fact.

BERGEN: That's good. The prime contractor for the Space Shuttle was Rockwell, who had been the prime contractor for the command and service module [CSM] in Apollo.

MORRIS: Yes.

BERGEN: I know you worked with them to a small extent, at least, toward the end of Apollo.

MORRIS: Yes.

BERGEN: Did you see a change in the relationship between NASA and Rockwell as you shifted into the Shuttle Program, and maybe any benefits that had come from working with them previously?

MORRIS: Not any big material changes, no. There were a lot of benefits, because a lot of the Rockwell people also transferred from the Apollo Program over to the Shuttle. A lot of the NASA people did the same thing. So in many cases they were working with people that they were familiar with, that they trusted and could do business with. So there was no big perturbation in moving from one to the other. Again, the technical problems were different that they had to solve.

They had a role in the Shuttle Program that they did not have in Apollo, and that was Rockwell was responsible for providing the support to the systems integration effort in looking over the overall program, as well as designing, building, and operating the Orbiter. They did not have that responsibility in Apollo. So that took, again, establishing some different relationships and different boundaries so people were working together in a little bit different manner than they had during Apollo.

In particular, the higher echelons at Rockwell had a hard time understanding why their systems integration manager would recommend that the Orbiter give up something to help the boosters, for instance, even though it was better for the program. The Rockwell prime contract was really for the Orbiter, and then they were furnishing integration support. That took a little getting used to, but, again, as I said, it worked out quite early and the relationship was good.

BERGEN: How was the management situation different for Shuttle than it had been for Apollo?

MORRIS: The prime difference in the management was in the Apollo Program, the overall systems management was retained in [NASA] headquarters in Washington [DC], and they did the systems management. The Johnson people worked on command and service module

and the operations. Marshall people worked on the boosters. The Cape people worked on the launch processing. But they were all under the direction of headquarters personnel.

In the [Space Shuttle] Program, Johnson was established as what was called the lead center, and the lead center was given the job of the overall management of the program, technical and schedule and financial. The contractors were given all three aspects for the total program. That included the work at Marshall and the Cape. That, again, required a little bit different relationship between the centers. It, I think, worked quite well. The headquarters staff were more concerned with the relations with Congress, with the administration, working the—we called it the outside part of the program, the part not directly involved with making the Shuttle work and making the pieces and getting it flying. And they oversaw the technical development, but they were not managing it in a detailed manner.

BERGEN: You mentioned that headquarters people were dealing with Congress and issues like that. The Shuttle Program never seemed to have the support that Apollo Program did, financially. Congress never seemed to back it as well. How did this affect you and your development process and manufacturing of the Shuttle?

MORRIS: It really affected it very seriously and, I think, caused the overall program to cost considerably more than it would have had we had the kind of support we had in Apollo. Each year at budget time, the congressional committees would say, "Well, this year we are very strapped for money. We need you to scale your program down, push things that you wanted to do this year out into next year, because next year we'll have more money and we can let you then go do the things you need to do next year." Then next year came and it was the same story, second verse.

This required us to plan. We planned two or three years out in advance, and we would do our planning for the second and third year, and plan on the things we wanted to do. Then when the budget came along, we couldn't do it, so we had to go replan. In many cases this involved scaling people up and down at the various contractors, mostly down.

You would see frequently rather large reductions in force at the contractors' plants early in the fiscal year, and then later in the fiscal year as you got behind schedule, it would build up again in anticipation of the next year's budget. The next year's budget didn't come through, so you would have to have a reduction in force again. This lost a lot of trained people who were not there when you built back up the next time, so you had to go through the training programs, get the experienced people capable of doing the job back on the job again. So I think it had a major part to play in the overall cost of the program and obviously the overall schedule of flight.

BERGEN: You actually retired before the first Shuttle flight.

MORRIS: Yes.

BERGEN: At that time how did you feel about the Shuttle as a vehicle at that time, since it was almost complete?

MORRIS: I was quite comfortable with it. Technically the ground test program had been going quite well. The drop test program for the Orbiter at Edwards [Air Force Base, California] had been conducted, and that was successful. I think things were fitting together to give us the performance that was satisfactory. It wasn't all that some of the people desired, but it was a satisfactory level of performance.

I guess the prime concern in my mind at that time was the main engine, the SSME [Space Shuttle Main Engine] , which was the liquid engines that are mounted on the Orbiter but are fed by the external tank. That development program was a very ambitious program. The engine was technically a very advanced technology level, and it had some developmental problems which were being overcome about the time I left, but had not been completely solved yet. That was probably the main issue at that point in time.

BERGEN: What do you feel was your greatest contribution to the development and production of the Shuttle?

MORRIS: I think making sure that all the major elements went together properly in both form, fit, and function, that they all fit together properly and that they all functioned. I think the later flights of the Shuttle indicate that the integrated vehicle during launch has been relatively trouble-free. We've had very few problems with the integrated vehicle. Most of the problems have been individual systems or individual characteristics of some of the elements.

BERGEN: We talked to Mr. [John W.] Kiker about his development of the Orbiter carrier, and he told us that you helped him out in the model testing.

MORRIS: Yes.

BERGEN: Would you tell us about your experiences with Mr. Kiker in that aspect?

MORRIS: Yes. John came over to see me one day and said, "Well, don't shoot me, but I've got an idea that I want to talk to you about." At the time, if the Orbiter landed at Edwards

Air Force Base, for instance, and it was launched from Kennedy, you had to get it from Edwards to Kennedy some way. Early in the program, the design called for a strap-on jet engine, so that it would fly like an airplane with jet engines, you had to put in fuel tanks, different control systems, a very cumbersome thing to do. John's suggestion was to fly it piggyback, put it on top of a C-5 or a 747, some big airplane, and fly it that way.

He had looked into the history, and actually the British and the Germans both had used piggyback concepts back in the early 1930s and had been able to do so successfully. So we got interested in that. As part of my job of integrating all the systems together, there was a tradeoff of which was the better way to go, the piggyback or separate jet engines. We worked with that problem on a total program level for some period of time, and finally it was agreed that we would fly piggyback.

Then after that was approved, we realized that, well, we could actually launch the Orbiter off of the 747 and use it for approach and landing test, to verify that part of the flight envelope, which exercised a big part of the total control system. So it was an important part of the envelope.

John and I both had been building radio-controlled model airplanes as a hobby for many years, and I don't know which of us, one of us got the idea, well, why don't we do this with radio control. We can do it quickly, we can do it in two or three months, and see if the separation primarily really would work and work okay. So we got together, and John took the major responsibility of building the Orbiter part.

Can you turn that off for a moment? [Tape recorder turned off.]

So we decided that was a good idea. John took the responsibility to do the Orbiter part, and I did most of the construction work on the 747 part of it. We had two separate control systems, one for the 747 and one for the Orbiter. Had some very interesting flights. Of course, we were using strictly manual control. We had no autopilots, no automatic control systems, so we were strictly manual control, and it took a little while to learn how to

do that. We had some pretty interesting experiences with it. But once we learned how to fly the machines, then we were able to show the piggyback part of the program was really no problem at all ferrying it. We changed the relative angle of attack between the Orbiter and the carrier aircraft to make it a bit more efficient, but other than that, there were very few changes.

Then we got into the separation part, and the separation techniques that we used on a radio-controlled model was somewhat different than they finally decided to use on the full-scale vehicle, but it worked quite successfully. I think all of our separations were successful. I can't remember any problem there. We had some problems with flying the vehicles, landing them, but the separation part itself went quite well. John and I still work together, built models, and talk all the time.

BERGEN: That's wonderful. When they finally did the first main test, you had already left NASA, but I'm sure you kept up with what was going on.

MORRIS: Oh, absolutely. Yes, absolutely.

BERGEN: They decided to do the first test manned. How did you feel about that, testing the vehicle for the first time?

MORRIS: We actually made that decision before I left. The flight hadn't been accomplished yet. We had made that decision before I left. That, again, was, to a large part, a problem of systems integration work, what is the best way to go at this thing, manned or unmanned.

There were a lot of considerations on both sides. Going unmanned was much more expensive, because you had to develop a totally automatic system that could do everything the crew could do. It was longer in time and was not as likely to be successful, because the

human being has the capability of coping with situations—we call them out of the envelope—that you really didn't think about, you really didn't design for, but given that situation, the ground and the flight crew can work around a lot of things, like Apollo 13 showed. If you have an automatic system flying the airplane, it's much more difficult. If you haven't thought about the problem and worked it out beforehand, being able to handle it in real time is a much more difficult thing to do.

So ultimately the decision was made to go manned. There obviously was a bit more risk to the crew as a result, but the feeling was that the risk was not large and that it was an acceptable thing to go do.

BERGEN: It must have been very satisfying to see the first Shuttle launch be successful.

MORRIS: Sure was.

BERGEN: And all those systems working together. [Laughter]

MORRIS: It sure was. Sure was.

BERGEN: When you left NASA, you went to work for Eagle Engineering?

MORRIS: Yes. Another engineer and I formed the company, actually. There was no Eagle Engineering beforehand, so we formed the company and started it.

BERGEN: What did that involve, and how did that differ from what you'd done previously?

MORRIS: NASA at that time had a voluntary reduction in force that would allow you to retire early under certain conditions, and there was a short time period in which you could do it. So quite a few people left the Center during that short period of time. Many of us wanted to continue in the aerospace industry in one form or another, and a lot of the people went to work for prime contractors. We decided that we would like to operate more as independent contractors and consultants, and several of the other people who retired felt the same way, so we formed a little group, called it Eagle Engineering, that would work primarily with the major contractors and help them with their part of the job of writing specifications, writing proposals to the government, doing conceptual design. We did a lot of conceptual design work for them. And then worked through preliminary design and on into the program.

We did a lot of work early on with Martin [Marietta Aerospace], with Lockheed [Aircraft Corporation], McDonnell Douglas [Corporation], General Dynamics, Grumman [Aircraft Engineering Corporation]. We worked with most of the major aerospace contractors. It was four or five years later before we put in our first proposal back to the government to work directly for the government. Early on, we really didn't feel comfortable doing that, because we had so many friends on the government side, it looked like it could appear to be improper, so we decided that we just wouldn't even try to do that, we would go work for the contractors. It was probably five years before we turned in our first proposal to the government.

BERGEN: When you did start working back with the government again, what projects did you work on?

MORRIS: We worked on the Shuttle Program. We worked with both the government and the prime contractors after the *Challenger* [51-L] accident, trying to help understand what caused

that accident, what had been done in the past in certain areas that might be helpful to take a relook.

BERGEN: Would you tell us a little bit more about that specific work that you did?

MORRIS: Yes. We worked with Rockwell and with Martin, both companies, looking at their ground test program to see was there anything that was missed in the ground test program. We worked with the Thiokol people after it started looking like the booster, the solid rocket booster was really the thing that initiated the problem. Again we worked with them on their past ground test program, looking at what kind of test and analyses could be done to help isolate the problem and fix it. That went on for, I don't know, a year, I guess, that we were helping in those areas.

BERGEN: How long did you work with Eagle?

MORRIS: I worked very actively from 1980 until 1993 or '94, gradually retired. Since '94 I've still been associated with the overall management, but not with the daily activities of the company.

BERGEN: Your career has spanned almost the entire space program that's existed. Looking back, what do you feel is your most significant contribution?

MORRIS: Oh, gee, I don't know. [Laughter]

BERGEN: Big question.

MORRIS: That's hard to do. I don't know that I personally contributed a whole lot. I think the ones I worked on, Apollo and Shuttle, primarily, were very good examples of a team process. My part in helping make the team work efficiently, I think, was interesting and probably contributed somewhat. There are very few people, I think, who individually did things that they can say, "I did this," because it was such a team activity, that almost anything that anybody did affected someone else, and you had to go work with them as a part of a team member, to make sure it was the right thing to do or the wrong thing to do.

BERGEN: Do you have any special memories or any special time that really stands out when you think back over your career?

MORRIS: Yes, I think mostly having to do with the flight activity, the culmination of all the time that you spent during the design, development, and building of the vehicles. The first high point probably was the launch of the first command module at White Sands [Proving Ground, New Mexico] when we were testing the launch escape system, the first flight of the Apollo Program. It was a real high point. Obviously the first flights of the lunar module later on were really high points, Apollo 9 in particular, and then Apollo 11, when we actually got the thing down on the Moon and got it back up again. The early flights of the Shuttle Program, although I was not with NASA at the time, were still high points to me, that all of that process had produced a vehicle that really would work and do the kinds of things you wanted it to do. So those probably were the things that I would remember most.

Back very early in my career, when I was working aerodynamics at the Langley [Research] Center [Hampton, Virginia], I was working on some supersonic transport activities, conceptual designs for those, which turned out to be not too far different than the Concorde that's flying, that has been flying since then. I'm very sorry that the United States did not decide to go ahead and build a supersonic transport. I think we could have done it in

a more efficient manner than the British and the French. That may be a bit prejudiced on my part. But I think we were a little bit further along technically and could have done a little bit better technical job.

BERGEN: Are there any people that you worked with during your career that had a significant role in your career or had a special impact on you?

MORRIS: Oh, yes. There were a large number, really. Herbert [A.] Wilson [Jr.], who was my first supervisor at Langley when I first got there, did an awful lot to help me become a reasonably good engineer, just being a green kid right out of school. His life had been in the research end of the business, and it was a totally different environment than I was used to. He helped me a lot in getting accustomed to that.

Another person that had a big influence on me, I think, was Joe [Joseph F.] Shea when he was Apollo Program manager at Johnson. He was a very energetic kind of a guy, and his style, although it was a bit abrasive to some people, I think caused the program to come together and to make progress much better than it had in the past.

After Joe, certainly George [M.] Low was probably the most intelligent and the best manager I ever worked with. I think almost anybody that worked with George Low would say that. I think that's probably a universal opinion. It was really a pleasure working with that guy.

Another person that had a significant influence on me was General [Samuel C.] Phillips. Sam Phillips was in the headquarters in Washington [DC] as the overall seer of the Apollo Program, but he had a very good management technique and he worked with people and with organizations extremely well. I think watching him, seeing the way he operated helped me in the integration world later on to a very large extent.

I can remember one time, the first time I'd ever really been with General Phillips, just the two of us, I was working at my desk and he just walked in the office one day and said, "Have you got a minute?" Of course I had a minute for General Phillips. [Laughter] So he sat down and we chatted a little bit. He wanted to know what I was doing, what my group was responsible for, how we were going about it, what our troubles were. Then he sat back and said, "You know, I'd just like to know what I can do to help you." And I still remember that. That really did impress me.

So I told him a couple of things, and, sure enough, he did something about them. It wasn't just idle conversation with the man; he really wanted to know, and he really followed through on it.

BERGEN: That's terrific.

MORRIS: Those were probably the three people that I would pick out as having major influence on my life. Dr. [Robert R.] Gilruth, although I never worked real closely with him, was always a friend, always a helper, and, I think, an extremely good manager. I think his running the Center was really a strong part of the overall space activity.

BERGEN: You've seen so much happen in space exploration and aeronautics. What would you like to see happen in the future?

MORRIS: I think many of us would like to see more support for the space program politically and with the general population. I don't have any magic way of how you would go about achieving this, but I sure would like to see that kind of increased support. I think it's important. I think the things that space has contributed to society has been out of all

proportion to the amount of money and effort that's been expended. If you look at our communications industry today, largely satellite-based, if you look at— [Brief interruption.]

I think if you look at the communication industry, you look at the weather service that we have, you look at the military capability that we have had, just the fact that we've had it, I think has prevented a lot of conflict. Our total life is greatly different because of the space program, and I think it will continue to change a lot. I think it deserves the public support. So that's what I would really like to see.

Technically, I would like to see us build a supersonic transport, still. I think it's coming. I think now, with the research that's been done over the last twenty years or so, it can be much, much more efficient than the airplanes flying today. I think that will happen. I just wish it would happen a little bit quicker so I get to see it. [Laughter]

Space exploration, human space exploration, I think, will continue. More support would always be a very advantageous thing. I think we will go to the Moon again, and I think we will go to Mars ultimately. With the time scale, I have no idea when there really will be enough support to allow us to go do that.

BERGEN: Is there anything else that you'd like to say in conclusion, before we finish up?

MORRIS: Not that I can think of. It's been a real pleasure, and I thank you all a lot. I think the job you're doing is a very important job, and I'm really encouraged that you're doing it.

BERGEN: Thank you. We appreciate you spending time with us and sharing your history with us.

MORRIS: You're quite welcome.

BERGEN: Quite enjoyable.

[End of interview]