ORAL HISTORY 2 TRANSCRIPT

JOHN W. KIKER
INTERVIEWED BY SUMMER CHICK BERGEN
HOUSTON, TEXAS – 12 MAY 1999

BERGEN: Today is May 12, 1999. This oral history interview with John Kiker is being conducted in the offices of the SIGNAL Corporation, for the Johnson Space Center Oral History Project. The interviewer is Summer Chick Bergen, assisted by Kevin Rusnak and Tim Farrell.

Again, it's nice to have you back.

KIKER: Thank you.

BERGEN: Today let's talk about the work you did with the space shuttle orbiter. You did numerous things prior to that, but that's probably what you're most well known for. Could you take us through the process of how you came up with the idea for the Shuttle carrier aircraft?

KIKER: Yes. The early concept of the Orbiter, and I became involved, of course, Dr. [Maxime A.] Faget and the Engineering Directorate, he had a meeting over in Building 13, and a number of us were there. I'd say probably twelve or fifteen or so people, with Dr. Faget. He was describing that we were going to go, which we were all aware of, and there had been a lot of studies about flyback boosters and flyback shuttles, and trying to save money and to be able to reuse them quickly, and make a lot of missions. So it was a typical, in my opinion, a very orderly step going from the Mercury to the Gemini, to Apollo, and then to a flyback-type vehicle.

At that particular time, of course, I was in what was later the Structures and Mechanics Division, and I had had the landing systems relative to the parachutes and the impact attenuation and crew couches and things like that, had been under my direction pretty much as the engineer.

So when the Orbiter was conceived, the initial intentions was to have engines, and the engines would be stored in the payload bay, where the payload is now carried, and then after reentering, they would deploy. After they got back to Earth atmosphere, they would deploy like the doors and have jet engines to where they could fly up to an area if they weren't located in a good area to do that. The more in the studies, as it progressed, it became very evident that they couldn't do that because that would take up all of the payload bay, a large percent of it, and then they really would need like a fuel system and a different type system for the jet engines. So you would be faced with how do we carry other type fuel or have engines that you could really use [for the landing]. It was getting to be a very complex arrangement.

So then it was determined that the right way to go was to come back as a glider. That was done on a very high level. That was basically Faget and, of course, headquarters, and Dr. [Robert R.] Gilruth and Dr. [Christopher C.] Kraft [Jr.]. It was a very high-level sort of study. So when that occurred, then it ended up being a very—all of the specifications were written for the Shuttle and what they wanted, and it was put out for bids. There were a lot of bids. Of course, in that, Rockwell [International] ended up winning the bid for going with the Shuttle.

Now I'll have to say that there were a lot of people did not think that Rockwell was necessarily the ones to go with, and it ended up that a lot of people liked McDonnell-Douglas [Corporation] because they were easier to deal with. We had a great big—and believe it or not, I did keep, deliberately, I kept the team. I was in charge of a team that had the landing systems and things of that nature for the Orbiter, and I had been keeping the evaluation, because I felt like it might go to court or might get into papers and there might be some argument. I held the evaluations, my rough thing. It was all graphed up.

The choice was fine, and they did a good job. They were just significantly, Rockwell was, from my perspective, significantly more difficult to deal with than McDonnell-Douglas. McDonnell-Douglas was very cooperative. And, "Old Man Mac" of McDonnell, he just would do things for you. Now, obviously Rockwell did things according to the contract, and I'm not in any way trying to imply that it wasn't done correctly. It was just more difficult to deal with.

Well, when they did that and then they didn't have engines, and it was being built out in California, then the question became, if we're going to launch it from the Cape [Kennedy Space Center, Florida] as things progressed along, is how do you get it to the Cape? The "how to get it to the Cape" was, they were going to then turn around and put four to six jet engines on it, and they were going to put in a fuel system and a control system. The design at that time for the landing gear was a four-degree negative angle of attack so it would help stop it when it came back to land, to get the drag.

So if you were going to fly down there, then you'd have to have a landing gear that would get that four degrees out of it, so it would entail two landing gears to do that. Studies of how to do that when the compartment was designed only for the four-degree negative, which was a lighter and shorter landing gear, that you'd have to have a telescoping landing gear. My fellows did design one, and I still have the drawings for that.

So it became really a tough question, because you put in a flight control system and you put in a fuel system and you'd have to make six stops, roughly six stops. The range was only going to be about 450 miles, and it was a very high landing speed. Then the takeoff to ferry it.

So then they decided that perhaps they could put it on board ship and they could go around the water and take it to the Cape. That was estimated to take fourteen days, and

Rockwell estimated it would be a million and a half dollars a day to do that. So we were talking 20 million dollars to put it on board a ship and to take it around.

Then if we test-flew it out at Edwards [Air Force Base, California], then you had to have a way to get it to where the water was, to where you could put it on board. In fact, they assemble all of this over at Palmdale [California], and they had a great big parade and, I think, let all the schools out, and they towed it from Palmdale over to Edwards. They went all down the road, and that was a big exercise. I've got a few pictures of all these school kids and everybody looking at it being towed. The reason for that was, they were afraid that—and they had the [Boeing] 747 at that time, but that runway wasn't nearly so big, and they didn't have the experience of flying with an Orbiter on top of the 747, so they were sort of afraid to fly out of Palmdale for the first go-round, where at Edwards they had twenty miles and didn't have to worry about it. They had plenty of runway and everything to do that at Palmdale, but here again it was a safety issue.

So they then flew. Of course, they pulled it over there to do the flight testing. So it became a question, from my perspective, that when I got to looking at it, I said, "Gee, if I change out a starter on my automobile or I redo the brakes, I go and test-drive it and invariably I've missed something. I have to go back and fix something to make it right." Now, if we had six jet engines and we flew that down to the Cape, what a pain it would be to pull the jet engines out and to put it back into a spacecraft configuration.

So I was very concerned about that type of operation, getting the control system out and getting all the changes made. I didn't want to go through that. That was going to be a problem. So I said, "Gee, what can I do?" Then I said, gee, being a model-builder and sort of a really aviation buff for many years, I looked back, and there were quite a few airplanes, the British had a couple of airplanes where they had had a bomber that would take a fighter, and the Germans did that also, where you could take a fighter that didn't have the range and they needed protection for the bombers, and they would fly them off the top of the airplane. But both of them were powered.

We were talking a glider versus a powered carrier airplane. Could you separate it and all? Then I said to myself, well, I've dropped a lot of things out of airplanes. I had seen at Wright Field [Wright-Patterson Air Force Base, Ohio] we had a B-36 and we could drop an F-84F off the bottom of that. They had releases. And you could fly back up and reattach in the air. At air shows they used to do that at Wright Field. I always was amazed to see that. It was fun to see them drop and start up and fly, to come back and reattach.

So I had a lot of sort of experience, and then seeing the old British pictures. I had another film that I wanted to bring, and I loaned it to a doctor friend of mine, and I will try to get back, where the first one that was done, and it was a powered thing, was done by the British with a ramjet airplane off the top of an airplane, just like I'm doing it. They had a four-engine airplane, but they had a powered separation, so it was a little different from the way that I had. But I knew it was possible.

I did the aerodynamics. That's when I got the Boeing data on the 747 and I got the Lockheed [Corporation] data on the C-5. The reason I got the Lockheed data on the C-5 is both airplanes had the capability, and having been in the Air Force for eleven years, I knew that I probably could get a C-5 out of the Air Force without costing me anything. That was what I was thinking.

The 747 and the C-5 had all of the structural facilities in the airplane, all of the payload inside. The floor was all structurally built to take loads from dropping cargo. The 747 we would have to do some structural things to put mine in there, and I got all the data from Boeing and Lockheed. They gave it to me, and the flight test people made the arrangement without any strings attached. I didn't have to sign any paperwork. Their representatives here in the area got the data for me and brought it to me, and I couldn't believe that I got it like that, but it was through my flight test experience as a flight test [engineer] from the Air Force. That was how I was able to do that.

So I had sat down and realized, when I got the data, I realized that aerodynamically, propulsion-wise and structures-wise, I didn't have any trouble with either airplane. So we were to go to Wright Field. Then Owen [G.] Morris, of course, was big into that operation, and he was supporting it. But I wrote all of this up, how to do it. I wrote it all on a piece of paper, and I gave a copy of that, and I went to see Faget and I gave a copy of it to Owen. I told them that's how I wanted them to handle getting the Orbiter back and forth to the Cape, and that that was the correct way to do it.

Faget told me that I should really do it with models. I said I already had the models in progress. So we discussed that a little bit. He authorized me to take stuff home if I needed to, like instrumentation or whatever. Basically I didn't do that. I did have a few things, but I did have a piece of paper that I could do that. That was when my wife was dying with cancer and I just couldn't be away and spend all the time to late at night. I had a lot of sort of perturbations as results of it.

So I had made a drawing of all of this, and I laid it out. I took the C-5 and then I wrote it all up, that you could use a C-5 or 747, and I signed it. Then I made a sketch of all of that on my desk, without even my fellows knowing it, and realized that I could do it okay. Then I got one of my fellows to make sort of a clean sketch of it, which I almost brought for y'all to see today, and then I said that's ridiculous. We're trying to have an interview, not to look at all this stuff.

So it was a case that I basically had all the data. I gave the aerodynamic people out at the [Johnson Space] Center [Houston, Texas] the aerodynamic data, and I gave the structures people the structures data, and the propulsion people the propulsion data. I offered it to them and no one wanted it. No one wanted to look at it. They said, "You can't fly it. You can't separate it." So I said, "Well, okay, then I'll just have to do it on my own."

So with my own people and then [James] Kirby Hinson, who is retired and has recently moved back to North Carolina, he was a really fine guy, and my own people were really good. So I finally got them involved in it, and it became quite evident that it wasn't a problem to do it. Then Faget supporting me doing the models, he said, "John, I can't give you any money, but if you can do it with the models."

Well, we had a big meeting down here, and Langley came down for it. I had already contacted my Langley [Research Center, Hampton, Virginia] friends in the aerodynamic world and the structures world and the propulsion world. The Langley people came back with letters to me saying it's no problem to do, and they came back down to the Center and one of them stood up and said, "John's idea is not a problem to do," in the meeting, that it wouldn't be a problem. Then that really sort of shook people in the meeting what they were saying, because Langley is so conservative. Then they said it wasn't a problem to fly it or wasn't a problem to separate it.

Well, I had their letters, and I still have their letters, that I've kept. It's very interesting, one of the fellows, [W.] Hewitt Phillips, who was probably the best aerodynamicist at Langley, and Dr. Gilruth and Dr. Kraft and all would always have him to come down if they wanted to know something about the aerodynamics or problem, he would come down. He's a very quiet fellow, and he was head of all of the flight dynamics at Langley for years.

He's a big model-builder. Of course, the two of us are big in the modeling world. His wife died not very long ago, and whenever he comes down here, he would always come by and spend a day or two days with me. We'd fly model airplanes. He's still the finest person. You would have to really listen to him, because he speaks so softly. But he'll sit down and write exactly—and we had a big discussion about the landing characteristics and all, and he wrote me a very nice letter. I was having a big battle about that, too, and he wrote me a very nice technical note with all of his remarks as to how to do it. So I had that, and it did get basically changed to what I wanted. But it took a long time.

The problem primarily in all of this area was that the people that were in NASA here at the Johnson Space Center primarily had not been in the world of hardware and airplanes. I mean, they didn't have the experience. I had the experience of making things, and I had the experience of being a military pilot and a civilian pilot. So I understood the flying and handling qualities and things that could be done with it. So that was another thing, that I knew we just had to do something.

So when the engines were deleted, then the 747 and, fortunately, I had all that written, and I couldn't get—Faget was trying to support me, but I couldn't really get the Center. Aaron Cohen thought I was completely crazy. So I just ended up calling my friend at NASA headquarters and getting them to send a TWX [teletype transmittal, pronounced "twix"] to the Johnson Space Center saying, "Do it." He got very worried about it. I said, "Send them a TWX telling them to do the 747 or a C-5 piggyback system. That's the way to transport it. That's the way to test it," because without the capability, they would have had to strap six jet engines, four to six jet engines, on it, and to fly it to altitude, which they could have gotten about 25 or 26,000 feet out at Edwards, and then they would have made the assimilated landings, but it wouldn't have been the correct configuration aerodynamically with the jet engines. I didn't want that, because it was such a high drag configuration and low L-over-D [lift over drag].

Edwards had done a lot of lifting body work, so they had some problems. I have that film, too, that I got Milt [Milton O.] Thompson to do for me. He died with cancer several years ago. But I really should bring that in and let you see it, too. It shows you some of the lifting bodies and some of the problems and things of that nature.

So that was how it all sort of generated. Then the TWX was sent by NASA headquarters to the Johnson Space Center, so then they did agree to go with that. So then the story from that point was very straightforward. It was put on top of the 747, they did do the flights off the top of the 747. They put a tail cone like I have here, and I had another one where I removed the tail cone and that one is one that I've given to the museum. Then this one was a new configuration when it kept getting heavier and heavier with the gross weight and higher landing speed and problems with the landing. My solution to solving that was to put canards on there, because we needed wing area. That was a way I could get the wing area. They said, "Well, you can't fly that either and you can't do this." Aerodynamics gave me a very hard time about it.

Faget—I flew this, and it flew so much better than the other one. I flew it off of the top of the model, too. He was going to take it to Washington [DC] and made a film of it. He did go to Washington with it, and Washington said, "We don't have money to do a change to it now." There has been a lot of studies since then where they want to go up with higher payloads and other situations, and this is a way you could modify it. It could be a way to modify it.

Here again, the aerodynamics people were not too keen about doing something like that, but they weren't familiar with canards. It was easy for me. I just went back to Langley. They'd done canard work, and I went to Wright Field and they'd done canard work. So they sent me all the data. I went over to the library and there was about 800 reports on that. So it was easy for me to come up with a system that could have been done.

So I would like to tell you that all of this, I never had such fantastic help in doing things legally or illegally, providing me data. Edwards Air Force Base and the people out there were just absolutely super. Lockheed and Boeing were really great to give me their data and let me have it. Of course, at the Air Force, anything that I needed out of the Air Force, basically I had people at Wright Field that were still friends there. Most of them have now retired. But they provided me with help.

Then Langley, the facilities. Lewis [Research Center (now Glenn Research Center), Cleveland, Ohio], on propulsion systems. Marshall [Space Flight Center, Huntsville, Alabama], on boosters. I mean, it was a situation that when I look back on it, I'm just amazed at the cooperation and the willingness to help that I received. And then my own people. I had about forty people. When they got in the middle of it, it was just anything you need to do, whether it was late at night or help [build] models. Kirby built the booster here. Kirby built the booster, I provided some of the wood. It has two parachutes on it as a recovery system after it burns out. It was twenty-four rocket motors. He was a rocketeer, and we launched that.

We were trying to simulate a return-to-launch-site abort situation, so we launched it out there at the antenna range, and it went up about 1,000 feet. I was able to get it all back and land very nicely. It was a publicity thing to show you could do something. The models, the older models were based on the drawings that were given to me by Boeing, and then I modified some, but I still used good engineering judgment in building the models. The models were built very well. I got a lot of the shop guys and all to help. So it was a very fun thing.

I crashed plenty of models in the course of learning how to fly them, and I called the people up at Langley and I said, "How do you land one with such a high wing loading" like I was flying. I had two of these pumps, special pumped engines that I had gotten from a model engine manufacturer that he made. The first ones that were made he gave to me to put on a model. Then after they worked on the model, he sold pumped engines like crazy. As I said, I didn't ever buy another engine after that; he just sent me whatever engines I wanted to do that. It was a very good advertiser for him and, of course, it worked out fine for me, too.

So ferrying it, I went through the 747 again. The 747, I got [the] airlines to tell me how much it cost them to operate 747s per hour. Then they had a big surplus of airplanes out in the desert at Mojave, and they ended up having a 747 out there, one of the airlines did.

Owen and some of Owen's people made all the arrangements in getting that, and Owen was responsible for getting it modified by Boeing primarily. He did just a super job. We've just been very longtime friends since Langley, model friends, and still are very—and I've been much closer to him recently since his accident.

The story behind those C-5-type airplane was, I was going to go with Owen, and they were going to go up to Wright Field and talk to them about borrowing the C-5s and modifying those. Now, the C-5 has a T-tail and all the aerodynamicists down here thought that if we went by that T-tail with the Orbiter, that it might cause some flow problems and make it a little bit hard to handle. I said, "That's not going to cause a real problem. It goes by so quickly, it's not going to cause a problem."

The C-5 we could get on a bailment from the Air Force and it wouldn't cost us anything. The reason that I wanted to do that was that I got a C-133 from the Air Force, really, on a bailment situation to do the Apollo drop test. I had to have a big airplane, and I didn't have anything where we could drop the Apollo out of, so we took one of the C-133s and we removed where the back loading door was and put an A-frame in there, and then we put the Apollo in there so it was nestled up in there, and we could go to 30-plus-thousand feet with it, and then drop it out of that. We did go through some perturbations.

It was done over my letter. I didn't' have to have anybody. I wrote the letter to get that on bailment, and the only thing I had to do was to return it to the Air Force equal to or better than I got it. That was the only thing that I had to basically do. Of course, Rockwell got all of the A-frame put in there and did all that. We did all the Apollo drop tests for that. So I said, if I could get a C-5 like that, we wouldn't have to buy anything or do anything, so we would just go with it.

So Owen was going to Wright Field, and then I had a conflict and I couldn't go with him. So he goes up to Wright Field and he comes back and he says, "John, I couldn't get a C-5. The colonel said that they had to use all of their C-5s."

I said, "Owen, who did you talk to?" And he told me the colonel in the project office. I said, "Owen, you're not a military guy. The problem is that you've got to talk to the general of the organization. He's the man that says. You're not going to have a colonel tell a general, 'I'm going to give one of my airplanes to NASA to use for testing.'"

But in the course of it, he found, or they did, this 747, and it was bought for like 15 million dollars, and then Boeing modified it for some, I think 6 million or plus, something like that, to put on there. That was a very good choice. That was the best buy that ever got on that 747 out there in the desert. So it was all modified and used for a lot of other things. So through the program office and through Owen, then, primarily, that was arranged.

The C-5 would have worked fine, and there was no question about it. Lockheed came in and gave the presentations, and Boeing gave the presentations. I do have the copies, still, of Lockheed's and Boeing's presentation, and I have that documentation on that.

So, to summarize it, you can fly fine with it. There was some tail buffet when you put the model on top of an airplane like that, or a real one on top of it, with the vertical fin there, and Boeing was a little leery that it might have a problem with that vertical fin and have some stability problems, so they put the outrigger fins. I put them on my model. I didn't need it on my model, but I did put it on there, and I did get some vibration and I did have some problem with the models. They had to go through a dampness system on the 747 when it's on there, and it's been checked very carefully.

But the thing was, is that out of the—well, it was 20 million dollars was the estimate of ferrying it by water. They can fly it from California to the Cape in roughly seven and a half hours' flying time. The airlines say it costs them roughly 12,000 dollars per hour to operate the 747, just the fuel and all. I think that NASA now estimates it is like a million dollars. They have support airplanes to go along with it, and they figure that it costs maybe a million dollars.

But be that as it may, as a taxpayer, we are saving roughly 19 million dollars every time there's an [orbiter] transported back and forth. Then when it had to make an emergency landing out at White Sands [Proving Ground, New Mexico], we have an Orbiter still flying, because they went in there and picked it up and flew it back out again all right. So there are a lot of advantages, and it's been a good sales thing, too, because if you want to see crowds go around, you just fly that airplane with a [orbiter] on top of it. There's a lot of requests for that. They even flew it to Paris for the Air Show. So it's been a good publicity thing. Should they have to make emergency landing in some remote areas, as the potential of having to do after launch, then they would be able to go in there and pick it up and be able to fly it back.

So that's sort of how I got into all of it. I had the mechanisms and the mechanical systems and like the payload bay doors and the landing-gear doors and the landing gear and all of that under me and my people, as far as the government standpoint. I basically had my fellows and myself to write original specifications. That was given to Rockwell, and then they, in turn, modified them, then came up with a final-type document. But the concept and all grew out of my experience with model airplanes and experience in the military and flying airplanes and doing a lot of testing on big airplanes, B-52s and all, which was really good. I mean, you know, it just happened to be one of those things that I was in the right place at the right time.

Then I guess the greatest thing was, is that Faget was so supportive. I mean, in every way he was so supportive. I can remember very early in the game that Dr. Kraft said, "Well, I think you're crazy, but we've been directed to do it. Apparently we'll do it." He was funny about it.

I'll have to tell you one sideline thing out of it that was a negative from my standpoint, is that my division, leaders would not authorize me to go out there to see the separation of that model off the top—I mean the real one—off the top of the 747 at Edwards.

I was going to have to get somebody to stay with my wife anyway, but I wanted to go so badly to see it separate and be out in the desert and see it land. I had spent so much time. So basically, Owen Morris took care of seeing that I was allowed to go out there, but I still didn't have a pass to get out there on the lake bed to see the landing.

Well, when I got out there to Edwards, I just went up there to where all the flight guys were, and I said, "I'm out here and I had great difficulty getting here. I can't go out to the desert. I can't get anything."

And they looked around. "You wait." I had a front-row seat, but it was because of the flight test friends at Edwards that made that arrangement. So I was right there and I was able to see it on TV screens, and I was able to look up and see it, and I was able to see it as it landed out there.

I never could understand. I couldn't believe that I couldn't be written a ticket to go out to see it. So I did get to see the flight. I did get to see the landing, so it was all right.

BERGEN: That's good. You were telling us, when we were watching the film in there, that you actually walked the lake bed before it landed.

KIKER: That was early in the game, when we were trying to determine where we could land it. I had Carlisle Campbell primarily that did that, and he spent a lot of time out there. Carlisle is still the landing-gear wheels, tires, and brake guy over here at the Center. He's been there for many years, and I hired him. He went to North Carolina State University, but he was a year behind me. He was a big model-builder. I became friends with him because one time I heard a jet going crazy, a model, and he was flying the jet model. So we became friends and have been friends since school. Carlisle is just a very—he has two degrees and he's just a very competent guy.

So he was the one that I assigned, basically, to take care of making sure that the lake bed was all right. They had a lot of little what we call "soft spots." Then there was a lot of—there used to be a gunnery range out there and you could fine .50-caliber shells, bullets, out there that had been fired. I picked up some and I still have them. My son is a collector. So we wanted to make sure that we didn't have anything rough that the tires might be in, and that the soils was strong enough.

At the time, there was a fellow from Edwards that was assigned to do this for us, essentially, and he and Carlisle, they went all over it. They made sure that things were all right. Then I went back and then I walked it. But Carlisle and his friend at Edwards did all of the actual work in preparing it. Where there were soft places, he got the [U.S. Army] Corps of Engineers to go in there and to bulldoze it and to pack it and to smooth it out.

The lake bed is very smooth and is very hard, generally. In January every year there's a big rain and it floods the lake bed, and for thirty days, approximately, you can't land or fly off of it. So the wind blows that water back and forth on that lake bed and it ends up, when it dries up, just like concrete, and it's just perfectly flat. So it's just very smooth. But there were some few places probably would have been all right, but, here again, it was a matter of making sure. So that was the way it was handled. They wanted that lake bed at first, then, of course, later they landed out there at Edwards and they've landed on the concrete runway and they didn't do that before.

BERGEN: You were telling us earlier about some of the challenges in developing the landing-gear system and you showed us a tire. Can you show us that again and explain to us on tape the engineering decisions that you had to make and obstacles you had to overcome in developing that system?

KIKER: Well, talking about the landing gear and the tires, I did, like most people would do, and here again I had a lot of connections with the industry primarily because of my Air Force connections. I had several people, of course, Carlisle being one of the primary ones, and I had done work with Goodyear, Goodrich, and all, Air Force-type operations.

So coming up with a land-gear design and coming up with a tire design and a brake design and all, the first thing you do is you research what has been done. We were talking weights, velocities much higher than the airline-type operations, but we were talking weights and configurations that it became very evident that what I should do is to contact all of the aircraft manufacturers that I knew and get all the data from them, if they would give it to me. They didn't even hesitate at all. They gave me their landing-gear data, their tires and what the speeds and all were for. We made a big table for it, and Carlisle made up a nice chart. We had all of that.

So it became very evident that we were going to have a problem. We had several problems. Number one, the specification for what the tire could weigh and the brakes and all that had been proposed in the specification as to try to do that, and Rockwell wanted to meet that, because they got a bonus if they met that. In other words, if they met what they said on their weights and all, they would get a bonus for it.

At that same time, Aleck [C.] Bond gave me 50,000 dollars to look into beryllium. Beryllium brakes were much lighter for the heat sink and the capability. Beryllium has another problem: it's very brittle and the dust is very poisonous. So if you breathe it and all, it can be fatal. So that was a problem. But it could be a lot lighter, so we started looking at that.

So we spent 50,000 dollars with the brake people to get them to look into beryllium. The Air Force was interested in beryllium brakes also for the high speeds and for the light weight. So we started that. The brake people had a dynamometer that they could test tires to fairly high speeds, but not at the speeds we needed, nor in the science that we honestly needed, but Wright Field did.

But in the course of all of that, we were asking for tire pressures and speed capabilities that was way beyond what was being done. So these tires were made with Goodyear people in Akron [Ohio], and believe it or not, all of these tires and automobile tires and all, they're laid up by hand. In calculating what the loads were going to be and the pressures, and the tire people, in the course of all of that, said, "We're going to need like twenty-eight plies." We had given them what the speed should be in the tire pressures. To have 200-plus psi [pounds per square inch] pressures in there, and we used dry nitrogen so it didn't change with temperatures. If you have just air in the tires and it gets as hot as it does in there, then they go way big, or it gets quite cold and you could lose. We had to have a seal.

Carlisle has gone one better now, as you always have tires that leak down a little bit. We didn't have any way, once it was locked up in that Orbiter, to know what the pressures were going to be. We put it in there at the right pressure, but if we didn't fly for two or three months, what was the pressure going to be? He's now gotten a way of measuring that and knows what it is while it's all in there. That's been since I've been gone. He's done a fantastic job on the tires and the brakes and all.

So the tires were made, and they were made by the Goodyear people up at Akron. They had to test the tires. We'd blow tires and they would blow tires. Then it was to try to get the lightest-weight tire that would hold up under—we had reliability factors and safety factors. So it was getting all of this beating where it goes around and around and around, so it wouldn't come off of the rim and would take the pressures and all. Then each one of the layers, of these twenty-eight layers, they're all laid up by hand.

I went to the plant, where the guy was doing it, and he's got a great big metal bar and he's got a big mandrel-type thing. He puts a layer of tires and he puts all these things in there, up there, and he's got a big bar. He's got a foot pedal and he can press that and it rotates. That big bar, he starts on one side going over the big mold, like they're going to put in. If it should hang up, that metal bar would get thrown out. So they had a big mark there as to where you should stay clear of in case that happened.

I asked him, I said, "What's—" He said, "You don't want to be close to that." I could see how it could really be a problem.

The fellows that did that, the one fellow that did that was very skilled and he had been there a long, long time, a number of years. It was very interesting. Then, of course, they put it in, they put it in the mold, and then it has to be cured. It gets heated and then it's taken out of that, and it's all trimmed and all inspected.

The biggest problem, and still is the biggest problem, is how you get a brand-new tire out and you inspect it and know that you don't have any problem. How do you know that you don't have some weak places or some bad places in the tire or in the sidewall or something like that? And that really has never been satisfactorily determined. They have ways of inspecting them, but still not what I'd say is a completely satisfactory way. So now it's just an experience factor.

So, Wright Field, Carlisle went up there and made a deal with Wright Field to use their labs and do the testing there, because they had the biggest dynamometer in the world and they could go to the highest capability, which was a lot less than the total, but they could go like 175 [psi], and we were wanting to go like 200 [psi] or better. We wanted to go quite high on the speeds. He got it all done there, and basically all we had to do was pay for their equipment and their labor, which was peanuts compared to what our tire people were going to charge us to do that job.

The other thing is, testing like that, we had a 15-knot crosswind capability where we had to design for and to take the potential landing crosswind, and we didn't have a way of simulating that. Wright Field had a way, because they could rotate the tire and put it on that big—it's a big concrete, steel thing that they spin up at these very high speeds, and they have a big framework around it, so if a tire blows, no one gets hurt. Then they've got a test center up where they can put the profile, just like a guy landing and braking and everything on a computer, and it loads it just like that. So it's sitting up here, then they speed up that dynamometer to where they want, and then they have the computer roll-out program that's put in there. So that tire comes down and it touches down on that dynamometer, simulating a crosswind. The load, it touched down, and then braking. It simulates all of that and it's all printed out on a chart so you can get that. If it blows or what happens, it's got this big case that catches the pieces if you blow one.

Aaron Cohen came up there with Smith from Rockwell to see a test while we were up there one time, and so we sort of gave the test people the word that we wanted them to blow the tire. They were all up there in this room where they had the bars and all, [prove] where they were looking out. I tell you, when that tire blew—and they didn't know that we were going to do that. Carlisle and myself, of course, knew. When that tire blew, I'm telling you, it got their attention when they saw that piece. It's just like a bomb going off.

So after landing, they came up with a way of putting big screens over the tires immediately, and we told everybody, the astronauts, "Don't go out there and kick the tires," and the first thing Joe [H.] Engle did was go out there and kick a tire when he got—and we all about died. [Laughter] Of course, as it was, it was all right and it worked okay.

So it was a contractor thing. The data from all of the industry gave Carlisle a good way, and we could write a specification that was reasonable. Never, never did I have any problem getting that information, which was amazing to me. It was very amazing to me. Carlisle, I mean, he's got files and files over there of data, still, and if anybody needs anything on tires, he can do that.

Of course, we had a situation where suppose a runway was slick and wet. Langley made a test fixture for tires, and we had a glass floor and all, and they had glass where you could simulate that and put tires on there, and they could have a camera shooting up. You could see where you hydroplaned with cars. They did that for the Highway Department, I believe. So we got a good indication. So if you go down to the Cape, you'll see where the runways are being grouped and all, and things that were done as a result of all that. Here again, I was concerned about it.

The British have a porous material that they make their runways out of now, where the water goes in it and it [absorbs] it, and then it will come out. So it doesn't just sit on top of it like that. If you go to California and around, you'll see a lot of roadways. If you go up to [Houston] Intercontinental [Airport], you'll see where they were all grooved. That came from the work that was done out at Johnson Space Center, Carlisle and all of us primarily with Langley saying what we should do.

One of the fallouts of it was that they have a lot of roads that have had grooves where they have problems with getting water and runways, badly. Now, they came back down at the Cape and it was tearing up tires more frequently for some cars, so they smoothed out some at the touchdown point to some degree. Then we had a problem of putting the lights down there on that runway, too, for tires. If we off-centered and hit one of those, we were worried about it. But you had to have the lights up a little bit so they're going to see them on the approach. So it was a lot of work for the landing gear, particularly both structurally and all.

Rockwell did a very good job. It was a good effort. I would have to classify it as the best thing in life is having tough problems and then tough guys find a solution for them. There's no such thing as not finding a solution for it; it just takes more money and time sometimes. It was just great fun, it really was. It was great fun.

BERGEN: We have a few minutes left on this videotape. Can you show us the portion of the tire that you brought?

KIKER: All right. This is the first tire sample off of the one that landed out at the desert, and you can see where it's been cut through it has steel ends, many of them, and this is a sample. That goes continuously all the way around because of the higher tire pressures and the potential of blowing it, that would keep it on there. Then there were twenty-eight plies. You can see a little bit the many plies that are in there, and then you'll notice that the tread is very skinny compared to what you think about in an automobile. The reason for that is at very high velocity, if you have much tread like you'd like to have on an automobile tire, it will throw chunks off and then you go unbalanced and you can blow a tire that way.

We designed it initially for five uses, but the cost of the tires, I think, basically now, and I haven't really talked—Carlisle is one to say—they probably have something they can reuse, but I'm not sure that they've reused any of them, but they've got a lot of tires. This is a sample off of the first one that landed. We ran tests on it, and I just took a sample of that so you can see.

It's all hand-laid up. Everything is laid up, and this was done with the Goodrich people. The tires now are made in North Carolina. Michelin, I believe, is making them, bought out, but they were made originally up in Ohio.

BERGEN: Thanks for showing us that. You also were telling us about some problems you had because of the tile on the Orbiter having to use different types of hinges for the landing-gear door. Why don't you tell us about that.

KIKER: Well, that was a situation that I did not have any experience with, but it became very evident that the thermal protection system that the structures and mechanics people had from the government side had the responsibility for, that it was going to be quite thick. On the bottom of the Orbiter and on the bottom of the fuselage it was going to vary from about like two and a half inches up around the nose, because the temperatures could be quite high, close to 3,000-degree [Fahrenheit] temperatures.

We have nose landing gear up there, and we have the doors that have to open to get that landing gear down. We didn't have like hydraulic actuators in there; we had a blow-down type door because of the actuators. We didn't want to have fluids. It was a weight situation, too, and it was a one-shot deal, so we had just what we called a free-fall-type system, where we would release it and then the landing-gear doors would open up and come down.

Well, with that thickness, and you've got to have it perfectly sealed for all the temperatures, so the doors have to close. So it's sort of like a four-bar pendulum, where they're in there, but to get the doors open they've got to drop down and then swing out, because if you've ever made a cabinet and you've got thick doors, and you try to put doors in there, you can't. It'll bind. I mean, you can't open it like you would do normally. Sort of like the hinge on the hood of an automobile. If you raise it, you see that sort of four-bar pendulum sort of arrangement to get the hood up.

So it was hinging it and making sure that it was properly latched, and then to get it all down with the nose landing gear, and then to seal all of that, because you've got the flow where the very high temperature is, and it's got to be properly sealed or it would go through and then you would really burn through. We ended up getting redundant seals, which is another whole story, the seal situation.

But it worked fine, and we did have a landing gear that you release… The landing gear had to be deployed in ten seconds, was the specification. Ten seconds seems like a long time, so they waited to twenty seconds before touchdown, before they put the landing gear down, because of the drag of the landing gear. That really reduced and made it a little tougher in the landing if it had done it earlier. So they didn't put the landing gear down, or don't put it down, till twenty seconds prior to touchdown. It was frightening to me to see the

Orbiter come down so low before the landing gear comes down, then all of a sudden the landing gear comes down.

Well, Rockwell came up with a very good way to do, is that if they release the doors and the landing gear weight of it in where it comes down with the wind, if it doesn't release and start down, they have a pyrotechnic device, and one and a half seconds, if it hasn't come down, then the pyrotechnic fires and blows the doors open. So you would get a landing gear. You're only at one and a half seconds' error that would be there from when it would normally—and so far that has been perfectly satisfactory and has been a very good system.

We did have a little burn-through on the very first Orbiter flight when it came back through one of the first seals on the doors, and that's all now, seems to be, working fine. The redundant seals saved the day then, and I was very glad that we had that. I was very glad that "Doc" Faget directed them, at my insistence, that we needed to do that. So they're still on there. They still have a redundancy arrangement. Rockwell put those seals on, and they didn't like it. They like it now, so it worked out fine.

BERGEN: You were telling us about your experience going to the first landing test of the Shuttle. There were thirteen of them. Did you get to keep up with them?

KIKER: There were five actual landings at Edwards. Originally the program called for like fifty, and they made five actual test landings at Edwards. The last one essentially was with no tail cone on. The tail cone was to give them a little bit better L-over-D. So the very last one Fred [W.] Haise [Jr.] was the pilot of, and he separated and he just had time to come around and to make his approach. He had a little flight control difficulty, too, and it was probably the hardest landing in a skipoff. This other film that I have, I show all of that. If you need it, I will get it and bring it back to show you.

Then they got that all squared away. But essentially, you know, the five landings gave them confidence that they could fly it okay and they could do all of the landings satisfactorily with it. Obviously that, and the computers and all, and the training, pilots just do a fantastic job of landing that every time. I'm just amazed at how consistently it is just really a great thing. And it had been planned. It had been planned in the earlier requirements that they would do automatic landings.

Karol [J.] Bobko, Colonel Bobko, who was flying, was to make the first one, but he said, "John, I'm not going to make any automatic landing. I'm going to fly that, and I'm going to make the landing." Karol I gave a very hard time. We talked about it. I was down there at the Cape. Then he's the only one that made a landing and he landed and everything just went great, you know, and he made a good landing. He was rolling out. This was his story to me, was, "John, it just seemed fine. I looked up and said, boy, the end of that runway was really coming up fast." He had plenty of time to get stopped. So he got on the brakes pretty hard and he blew a tire. So he's the only one and the only time we've blown a tire, and I really gave him a hard time about blowing the tire. Well, as it was, he was very close to being stopped anyway. But he said, "I just jumped the brakes to do that."

So that's sort of the situation with it. Five was considered adequate for the separation and the flying, and did the one without the tail cone, and that was fine.

BERGEN: You were also involved with the Shuttle crew escape system, weren't you?

KIKER: Yes. That was a very tough, very tough issue. Originally the specification we're talking about we were going to have an airline-type operation. We all knew that it wasn't an airline-type operation, but the further it got along, I got very concerned about having a way for the crew to get out of it. I wanted ejection seats. There are all kinds of ejection seats and types of ejection seats.

It was a difficult sell, plus I had ejection-seat experience from Wright Field, knowing the people and seeing the tests, and providing automatic opening devices on the personnel parachutes, which Kirby Hinson and myself had. I had the responsibility, and when he was there, he was with me. But all of the personnel parachutes from the Air Force had had automatic opening devices. The devices came from our taking over and doing the testing and approving it. We got assigned that job as one of the projects.

So the background said, even on the runway, that if the Orbiter got down on the runway and had any problem with something, to have an ejection seat to get out was very desirable. The Air Force now has, as you know, zero-zero capability. That means they can be sitting still on a runway and they can fire it and they'd get out. So I wanted to have that capability. That, here again, was my association with the Research Section of the Parachute Branch, a long time there.

It was finally agreed that for the first flight we could probably put two ejection seats on, that they would consider doing that. Then Rockwell had one approach to that and wanted to use a Rockwell seat, and I didn't. I wanted to use the Air Force one that they were using on the YF-12. The reason for that was, the YF-12 ejection seats, I had knowledge that the Air Force had made three successful ejections at roughly 70,000 feet at mach three or better than mach three. It was being done by the skunkworks at Lockheed, but, of course, the Air Force was the one that was requesting it and had done that.

So we contacted Lockheed, and Lockheed was willing to provide us information and all. The Air Force was willing to provide us information and let somebody be involved there with the skunkworks, but we had to have a top-secret clearance and we had to have a safe to be able to store information. So to make the long story short, Bill [William W.] Lofland was the fellow that I assigned to that job, and he was an ex-Air Force fellow, too. He was at Wright Field and I knew him from years. He was working for us. So he knew all of the Air Force ins and outs and had the background, so he was assigned to that job.

It was a lot of politics, but I was supported, and Rockwell was not given the authorization to use their ejection seat. Now, they had a pretty fair seat, but it was not the capability that this YF-12 seat was, nor had they had actual ejections at this high altitude and the speeds that we could have possibly been into. They also had a life-support system that was a little bit different because free falling from 70,000 feet down to where you can put a parachute out takes a pretty long time and you need more oxygen and all than normally you would have with like an Air Force pilot or whatever.

So we got all that. We got the authorization. We got the authorization to put the people, for the pilot and the co-pilot. We ran the tests, we made the tests, we used the high-altitude data that had been accomplished from the Air Force as proving that it was okay there. We did a little changing.

Then we did sled tests out at White Sands, where Rockwell built a mockup of the cockpit. The difference was that we had an inner and an outer shell that we had to cut because of the way the Orbiter is made, versus the way the SR-71 or the YF-12 is built.

So then we were faced with the design of that, and Rockwell came up with a lot of good ways to do this. Then if you cut a hatch, you often get little particles that would be around your head. We had to be very careful about that. So Rockwell came up, one of the Rockwell guys did, with the thing that really made that nice. They took a tube and they put the pyrotechnic charge inside the tube, and then they flattened it. Then it was put up there where they had to blow the hatch. When that blew, the tube expanded and blew the hatch open, but it retained all the particles inside. There were no free things.

The inner one was cut, and the inner and the outer container, the hatches, the inner one, of course, being smaller than the outer one, we had cables to hold the two together so that they would rotate, and they rotated at the back so they would go clear. So that kept everything away from the crew, and they could be right up against it, and when they blew the hatches, it would be all right.

Now, part of the reason for all of that is that even on the ground, we wanted to have the capability, and then we had a very big vertical tail. So the two seats on the zero-zero capability on the ground, you need to have them separated. So that ended up being a very simple job, and we ran the tests at White Sands to prove that, is that the rails where [the seats] come up, to keep them stabilized to go out, cut about four inches off of the outer rail on both sides. So as they would come up, then they would leave there and then in the air flow they would separate and it would move the two away. That was tested out at White Sands on a sled test. Bill Lofland was the project engineer, and there's some very good film relative to the test. So it was proven.

Then after the first flight with it, the first flight, they made a total of four and then were told to take the ejection seats off, that we had an airline-type operation and we were to get rid of the ejection seats. I must confess—and then, of course, it didn't have quite all of the instrumentation panel and all of the switches and things they would have needed, but we still could have used ejection seats, and there's some others. We could have gone—we had the capability, from my perspective and my engineering look at it, we had the capability to put four seats on, four ejection systems that we could have gotten people out all right.

The decision, it's one of those things that it was just so much involved politically, money-wise, engineering-wise, and you say, well, we fly airlines and we don't have ejection seats, but airlines are entirely different. They have a lot of flying time, they can do a lot of testing, a lot of different things, and I just felt like that it was by far better to try to put an ejection seat on. But I was told that they should be taken off, and they were taken off. I think four flights were made with the seats.

The other problem, of course, is that if you are on launch and you use an ejection seat, if you eject at like 70,000 feet, you're going to go up another 10,000 feet before you turn around and come back, so you've got a long free-fall time. Here again, the Air Force had come up with—see, they had a little stabilization chute, so they kept you stable all that free fall. I mean, they had a system that—they did a very good job with Lockheed, and they had tested it. They had success. Of course, nothing can beat success and people that come back and tell you about it.

So I still would like to see emergency escape system, and I've always felt like that we should have had some way to get out of it. Yet the decision has been a good one, and so it's one of those things that, what price do you put on life? And you know it's a dangerous game and all the flight tests are very plain. We've lost people and we're going to continue to lose people. That's the game of trying to do something better for people. That's part of it. Then if I look at it, right here in Houston we lose seven to ten people every weekend for homicides or accidents, and no one pays any attention to it. "Oh, we had an accident. We had so and so killed." You see this wreck on TV or whatever.

I really don't like that philosophy. When I get in an airplane, at least in my own airplane, anything that can work is going to work. I mean, I'm going to personally see. John likes John. [Laughter]

BERGEN: Are there any other aspects of the work you did on the Shuttle that maybe I didn't ask you about, that you'd like to discuss?

KIKER: Well, we talked about the seals and the payload bay doors. The payload bay doors, I was very concerned about all the latches, and all the latches working correctly, and having some redundancy. If you had one that jammed, what could you do? We did do a lot really to that. So far it's just been amazing. We had a lot of micro switches operating. Micro switches are notoriously prone to failure on airplanes. If you see a landing gear and you get warning lights, you very often maybe have, and it just happened that I checked—I went up here to Ellington [Field, Houston, Texas] and I went to the airlines. I went to their shops here in the Houston area, and they had one on jacks. It happened to be a Continental airplane. They were having trouble. They thought they had trouble with the landing gear, and it was a micro switch problem. The landing gear was working all right, but the micro switch was giving them a false indication as to what was going on.

So I was worried about micro switches. I don't remember the exact number, but it seems like it was around 270 or 280 micro switches on all the payload bay doors, with all these latches. You know they're actually four doors, two on either side. Then you've got the radiators that come back up. So I was concerned about, suppose we don't get them closed and we have to return. What do you do?

It ended up that the people in another group there worried about tools to repair things and tools to cut out latches, and that's what was done. We ran a lot of tests, but we didn't have a way of simulating the payload bay doors in a zero-G, and so it ended up that it made all the mechanisms on the ground, and we put cold temperature on them and heat on them, and we operated the mechanisms to try to get the mechanisms working okay. Then later they had an Orbiter down there in the VAB [Vertical Assembly Building] Building, where the doors, hanging vertically, where they could open them and close them.

So far as I know, there's been no malfunction with any one of the micro switches or any one of the latches. I think it's absolutely marvelous that that has occurred. Sometimes they didn't want to open at all, and it was maybe a little cold, and they just turned around and got a little sun, then they worked fine. I asked Hoot [Robert L.] Gibson that, and he said, "Oh, John, we haven't had any trouble. It's all been all right." Everyone so far has—I haven't heard any.

I don't see any of the reports coming back, but it's just been amazing that 60 feet long—if you've ever tried to get things out of there, you've got all these latches. So you zip on the back, you zip it up, you zip the front up. You go to the latches like that, so you don't have individually. Then across the top, the temperature difference is that you can have a—it's like a three-inch thing. The doors can change from front end to back end when it's in space by three-quarters of an inch. So we had to have latches that could reach quite long to catch, to pull them in from the differences in the temperature.

And still it's all worked fine. I mean, as far as I know, it's all worked fine. I think that's the most amazing thing of all, is to make the fights they made and the payload bay doors and everything to work as well as they have, the latches. And I must admit—and the other one was, of course, with the close-out doors on the [bottom]. After you go into orbit or after you get rid of the tank, then you've got to close those doors. Then you come back and it's very hot and all.

But I wondered about those doors closing properly, because where the attachments are, the doors are like four feet by 50 inches, and they're rotated out of the way. Then they sit on the attachments to the tank, and then after the tank is separated, then they've got to close. With all that shake, rattle, and roll, and what do you do to hold them open and how do you get them all closed.

Dr. Faget came up with a way of doing that with just one thing. He came over to the office and he came in, sat down, made a little sketch, and he had a blade in there that would lock those two doors. It just worked perfectly. So I have to give him full credit. He's very clever anyway, and very smart. Rockwell didn't want to put it on there, but they did put it on, and everybody's very glad they put it on. I was delighted.

John [W.] Young used to come over to my office, seemed like every morning for a long time, "What are we going to do about those?"

I said, "John, I'm worrying about it, too, but we've got to do something. We can't afford to not do something to hold them properly."

Then no one ever even thinks or talks about it; it just works perfectly and it's been good. So it was really a Faget idea.

BERGEN: Before we leave the topic of the Shuttle, would you show us your models that you brought for us today?

KIKER: This is a model with the tail cone. This is not a removable tail cone. I had another one that I donated to the museum, that was made just like the present one. This is scale, 40th scale, two and a half percent, without drawings and all of the things from Rockwell, so it's made accurately. It's not like you normally do with a model airplane. A model airplane is just a model airplane, just a model airplane. This is made very well. I mean, it's accurate pretty much as we could make it.

Inside, I had a control system and I had it to where I could operate it like on the real one where I had elevators, could put them together for elevators or I could differentially use them for roll control. Then I had the speed flapper brake in the back, and I didn't bring that with it, but I could put that down, too. So I had the same size and the same operation.

Then I had the rudder was correctly and it has a mechanism where I could put out the speed brakes like they do and it can go, you know, very wide, about thirty degrees either way, and maybe still operates only as also a rudder so you can have them out and use it as a rudder or you can come back with it.

Inside here I had all of my model airplane radio control equipment that I had fixed up and modified to accomplish all of that, and so this is one of the models. One of the fellows over there in the shop made it. I use molds that had been used for a flotation model, that I used for a flotation model, to make this part, and then I modified this. I had this modified. So some of my friends over there did that. Then I did all of the changing, and I cut a hatch and fixed all of that. I put all the radio gear in this. This one was originally like this, but we had some aerodynamic problems that I was trying to get squared away on the proper CG [Center of Gravity] and to find out what should be done.

So if you look here, I've got a plate and a plate, and I mounted it like this. That plate is moveable so I could change CG positions. By doing this, I could take, and I went down to Ellington and got Tom [Thomas M.] McPherson, who's still down here at the Center, modified a truck, and we took and put a great big ring around it. Then we had a rod going through that, this on the back of the truck, and it was way up above it, so I would have clear air from the truck. We modified it like that. We got permission to run on the runway down there, and so we could run thirty, forty, fifty, sixty, seventy miles an hour, and we could fly it.

We had a radio control system in there, and Tom would sit in there with the radio. Then he could operate the controls. We had a hot wire anemometer to measure our speeds, so we had very accurate speeds. Then we had a camera mounted that gave us angles of attack and also we found out, by doing that, just exactly where it was stable on the CG. Then we'd just slap back and forth when it was unstable. Then when you could fly it, then we could go up to where you could fly it, and then we could hold whatever angles of attack we wanted. Then we knew we could fly, and that's how we determined what the CG was for the correct flight.

I had intended to do that in the wind tunnel, and then I wasn't allowed to use the wind tunnel because they had it used for another aerodynamic thing, and I was going to use the one up at Texas A&M [University]. Since I had build models for A&M, for their wind tunnel, on the side, I knew the facility, and so that was a way. That was my wind tunnel, and it proved it very successful. So that was a cheap way to do it for the government standpoint, and I just used the truck and it worked out fine.

"Doc" Faget even had that test facility put in one of the test facility books for the year. I happened to be out of town. Kirby was told to write it all up and put it in there, and gave it to me. So they had this as one of the test facilities, was that truck with that big ring.

And I bootlegged that from the shop. I knew the people, you know, and I got it all made. Here again that's knowing the people.

Here again, that's the advantage in having the mechanical skills. I knew shops, I know woodwork, and I knew metal work. So that was a nice advantage. The people in the shop, Tom just did a super good job. They had all kinds of cartoons on my door coming in the mornings, and I couldn't find out. I should have brought one. It shows me with a transmitter [unclear] and Tom down working on the model. "Tom, we need to get more speed out of this if we're going to compete with Langley Research Center." Cleverest drawn cartoon, and one of my guys had done it, wouldn't sign it, you know. And it would be on my desk. [Laughter] I've kept them. I prize those very much.

So it was a cheap way to do it. Now I find out that I can very quickly, if I want to do something in the way of model-building, if I want a little wind-tunnel data, I can just take and put a big board out my car window and I can mount a model like this. The reason for mounting it on sideways is, see, I don't have gravity effect on it. If I have it like this and then it's pivoted, it's going to flop back and forth. But if I turn it like this, then it's perfectly all right. So that's the reason for mounting it on the side. In a wind tunnel, you would have it mounted in here and you'd have three points. You'd have a point here, here, and a point up here. Then you could get pitch, and then you could rotate it. They've got a big round circle so you could get angles of yaw on there. Well, you have to do little tricks with the truck to get what you need out of it.

BERGEN: Great.

KIKER: And I just modified this one, as I was telling you earlier. I modified this one because at the time they wanted to go with—considered going with much heavier payloads, and our landing speeds were getting high. I add wing area, and this is a fixed wing, and it would just take too much to modify that, but I could add wing area by adding a canard, is what I was trying to do.

BERGEN: Great.

[End of interview]