NASA STS RECORDATION ORAL HISTORY PROJECT
EDITED ORAL HISTORY TRANSCRIPT

DONALD H. EMERO
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is August, 26th, 2010. This interview is being conducted with Don Emero in Downey, California as part of the NASA STS Recordation Oral History Project. The interviewer is Rebecca Wright. Also present is Bob [Robert] Sechrist, who is videotaping for the Aerospace Legacy Foundation. Thank you for coming in this morning and visiting with us.

EMERO: My pleasure.

WRIGHT: Could you please start by briefly telling us how you became part of [North American] Rockwell [Corporation] and then how you began with the Space Shuttle program?

EMERO: My first job after I got out of graduate school was with North American Aviation [Inc.], which became [North American] Rockwell [Corporation], and now [The] Boeing [Company] after many iterations. I worked for 37 and a half years in the industry, 30 of them with Rockwell.

WRIGHT: Tell us some of the first jobs that you had when you came on board.

EMERO: The first job—the Air Force awarded North American Aviation a contract to design the XB-70, an aircraft that the Russians [Soviet Union] couldn't shoot down. A design criteria was to cruise at three times the speed of sound, cruise at 70,000 feet. It was roughly twice as high as the commercial airliners go. At those speeds the vehicle would be subjected to aeroheating, so to keep the weight down on the forward half of the vehicle, from the air intakes to the nose was made out of a new titanium material. Manufacturing and engineering had a lot to learn about the material—how to work with it, how to make it perform satisfactorily, make sure we could assemble the two vehicles and they could perform at the required Mach 3 [at] 70,000 feet.

When the XB-70 made the first flight, they had it painted all nice and gleaming white. This was before paints were developed for the Apollo Saturn [rocket] which were made resistant to heating. If you had red paint, it came back red. On the XB-70 they didn't have any heat-resistant paint. So this nice white gleaming aircraft took off, went and did its Mach 3 runs and a few other things, came back, and it was a tan aircraft. All that heat scorched the paint job.

We built two vehicles in Palmdale [California]. I was helping out a lot, and that required lots of trips back and forth from the airport area where North American stored its transport vehicles for its own people. The first time I flew on it, when I got to the location where the flight office was, it was a DC-3 [aircraft]. I hadn't seen a DC-3 in a long time. They started making them in the 1930s, and as far as I know there's probably DC-3s still somewhere around the world still flying and doing a good job. Simple aircraft, but it was key to winning World War II—not so much because of their size, but because we had so many of them.

The pilot I knew came back from the war, and he told me that he served in the China, Burma, India theater. He was flying DC-3s "over the hump" from northern India into China. The first flight he took was with an experienced pilot and it was foggy and cloudy. The visibility was lousy. "We had to go all compass headings and altitude control." The second day it was clear. He says he almost fainted because the pathway that the aircraft was taking was a control flight down the center of these valleys. You didn't have to climb above every peak, you'd miss a lot of them at the altitude. But when those mountains went by—he said, "After that I became the most thorough checkout pilot in the squadron."

Any little blemish, anything not quite right was critical—because if you overloaded [the DC-3] and then you got into some really gusty wind conditions, the wing joints and the wings would twist slightly. Then the next time you'd try to fly it, because it's not a perfect airfoil aligned properly, it wouldn't fly with the same load it had carried before. So they had to send a checkout pilot with the first flight, to make sure you at least get it off the ground.

We only built two XB-70s. During the flight testing program one was involved with a midair collision. General Electric [Company (GE)] had a lot of jet engines in vehicles which were at Edwards Air Force Base [California] at that time. They asked for and received permission from the Air Force to get a grouping of all the vehicles that had GE engines. On the XB-70 delta wing, the wingtip would fold down with the top of the wing actually pointing down. That gave them better lateral control, because it funneled the air going over the wing right through that passageway between the two tails.

One of the GE demonstrators got pushed into the tail of the XB-70, flipped it upside down, went across the vehicle. It knocked off the two vertical tails, and then the aircraft went into a horizontal spin and it couldn't recover from that. So that left one XB-70. If you ever go to Wright-Patterson Air Force Base in Ohio, there's a beautiful museum there. The one and only XB-70 is still there. Now that I think about it, just about everything I've worked on is a museum piece.

WRIGHT: Except for the Shuttle, the orbiter is still flying. How did you transition into the Shuttle Program?

EMERO: I left Rockwell seven or eight years while I worked for a company that made a honeycomb sandwich product. During those years the biggest contract we won was to design, test, and install a new thrust reverser assembly on the Concorde [Aérospatiale-BAC supersonic aircraft]. One of the very few American firms that ever got any business with the Concorde.

A couple years ago I went up to Seattle [Washington]. They have a Museum of Flight there, and I asked to speak to the curator for the Concorde. I asked him, "Are you aware of any American firms that built anything used on the Concorde?"

He said, "Oh no, it's all British and French." I told him that the thrust reversers were made out of steel honeycomb. He said, "No they aren't. They're just regular."

So I said, "Want to go take a close look?" He got a stepladder, a flashlight and some kind of tool where he could burnish the surface so he could see some reflections.

He goes, "Oh my God, you're right. I never knew that. Nobody knows that." The British and French governments want the world to believe that 100 percent of the vehicle was made in Europe. At least this part wasn't.

Remember that accident they had on the runway [Air France Flight 4590 crash]? When they were sorting through the debris, a lot of burned and/or partially melted aluminum. It was around 1,000 degrees. The steel thrust reverser, that's the movable parts, were still there. Their melting temperature is well above 1,000 degrees.

I came back from Europe after spending a year in England and three years in Paris [France] working on the Concorde project for a French engine company. The company had gone over the hump working on that contract for the British and the French. They only built 12 aircraft, so it was a relatively small contract. That was in the fall of ’73. A lot of my friends were already starting on the early days of the contract for the Shuttle. I knew, “I want to work on that.”

I had to come in for an interview at my level, MTS [member of technical staff]-5. The request to hire me had to be signed by a vice president, Ed Smith. After trying to find a date and a time for the interview, we ended up on a Saturday. He was so busy trying to solve technical problems, finally someone reminded him I’d been waiting all day out in front of his office. He came running out with a little hire slip and says, “Why are you looking for a job?”

“I really want to work on the Space Shuttle. I missed the Apollo/Saturn program, but this is a great opportunity.”

He says, “Come on board, plenty to do.” He signed it and I started work the next day in the structure/analysis department.

WRIGHT: Is that when you started on your project for the quarter-scale model? Tell us how you learned about that project and then how that project evolved.

EMERO: NASA did not believe there was a dynamicist in the whole country who could properly handle the Apollo Saturn structure—with the first stage, second stage, third stage—each level having its own power source and equipment pieces, which were heavy and would try to respond to the dynamic environment. NASA was convinced that there was no one who could create a math model of that complex structure, predict what’s going to happen, and get it 100 percent right. So NASA put into the contract with Rockwell to build a scale model of the Saturn V.

They put the same requirement in the Shuttle contract, because on the Apollo Saturn there was a couple modeshapes and frequencies that were not predicted by the math model. A similar story was the answer on the Shuttle. The solid rocket boosters are dominant near the liftoff phase. Big monstrous solid rocket motor engines put out a lot of energy and they cause a lot of vibration to take place. I am told that they completely missed, both on the Shuttle and on the Apollo Saturn stack—on modeshape and frequency, especially in the low frequency range. Apparently something about the math model wasn't hi-fi [high fidelity] under those conditions.

They chose quarter-scale, because the idea is if you make an aerovehicle that is scaled in proportion to the real article, you had to have some sense about what's important and what's not important. We have lots of small pieces of structure, like the vent doors and so forth, that are not necessary to replicate because they don't create or dominate any of the modeshapes and frequencies. They just go along for the ride, whereas other things like the access door to the midbody, were replicated. The scale is chosen such that you can actually make some fasteners. Once you get a smaller scale, like one tenth, then you can't even see the fasteners you have to use.

As we were walking along the hallway my boss told me, "Well, we got this interesting project for you."

I asked him, "Why do they need a structural engineer, stress guy, on a scale model dynamic test?"

That's when he laughed and he says, "I never told you the scale. The scale is one fourth size."

I looked around the room we were in. I said, "Wow. That's like a Piper Cub [J-3 aircraft] in here."

It’s really quite a vehicle. I always thought it would end up in the Smithsonian [Institution, Washington, DC]. It’s small, easy, lightweight, doesn’t take up much space, but it shows you exactly what the vehicle looks like. They had us build one orbiter, a pair of solid rocket boosters (SRB). Since after eight and a half minutes of flight, all the propellant is gone so they had us build a pair (SRBs) full and another pair half full so we replicated three stages of the ascent phase. We sent those tubular sections to Utah [Morton Thiokol Inc.] where they were filled with the propellant mass. The propellant mass was mixed such that it didn’t have the oxides in it that would burn or cause any kind of explosion. It was inert but it had all the properties. They call it a solid rocket booster because the fuel on the inside is not liquid, it’s solid.

Some of our guys who were working on models at the Los Angeles [California] division took on the job of making the quarter-scale orbiter. We contracted out the quarter-scale ET [external tank] and we built the quarter-scale solid rocket booster in house. We didn’t have very much tooling, so there was a lot of expertise brought to bear to get those things welded together. I think altogether from start to finish the total cost was about $10 million. For a program like the Shuttle, that’s insignificant. It’s a good thing we ran it, because we ran into the same math modeling problems that the Apollo Saturn did. In the low frequency range the math model wasn’t really predicting the actual test results.

The tests were performed in our structures lab in Downey [California]. They had the vehicle sitting on wheels there. They have this little motor with a plunger sticking out, and they can control the distance and the force that they apply to the vehicle. They’re holding this motor suspended in air, so you push a little bit and everything on that model starts to react to the energy that’s coming in. They all try to react at their own natural frequencies. You got the dominant natural frequencies from the primary structure and then all other masses—the APUs [auxiliary power units] and the tanks that hold the liquid oxygen, liquid hydrogen—they're heavy. A three-legged support for a tank looks something like a tripod.

We ran a complete dynamic test program. We had a lot of NASA guys there, and we got excellent results. They exposed a potential loading problem at liftoff for the external tank. I think we ended up changing the sequencing of how quickly the engines start one after the other, because they don't start all three at the same time.

WRIGHT: How long was that process?

EMERO: I'd say a couple years. It turned out to be one of the most interesting assignments I ever had, because there's no book that says how you do it.

WRIGHT: Did you supervise the entire effort or did you have a specific [role]?

EMERO: I was the only structural analyst working it. We had a dynamicist working it, we had a structural design engineer, we had weights and mass guys. The head was a project engineer out of the project office.

WRIGHT: Did you all agree on the results?

EMERO: We were told by NASA to make a math model, and in many places the math model and the answers by test would come out similar or exactly the same. But there'll be places or locations where the math model either didn't predict what's going to happen or it's a different answer. The orders were "if you find that the math model and the test results say something different, believe the test results and change the model until the answer matches the test." Putting all that effort into a hi-fi replica (there are duplicates and there are replicas—replicas don't have to be the same size, the replica is what we made) proved to be worth the effort.

The NASA man who was assigned to do that said, "Don, I know that you've written a couple papers in AIAA [American Institute of Aeronautics and Astronautics] journals. I'd like you to make a technical paper presentation out of this quarter-scale model."

I said, "Well, I'm not a dynamicist. This is a dynamics test."

He said, "That's okay. We've got a few people that can help within Rockwell, and I'm a dynamicist myself." All these papers that are submitted are reviewed by peers with vast knowledge.

I said, "How are we going to get past the committee?"

He said, "I'm the chairman of the committee."

I said, "Oh, that makes a big difference." You can find it, ["The Quarter-Scale Space Shuttle: Design, Fabrication, and Test"], 1979.

WRIGHT: What do you believe to be the greatest value of doing this quarter-scale project? How did it most benefit the program?

EMERO: Oh, a very important benefit. The math model missed, and the test showed, that at liftoff when the solid rocket boosters have just started—the vehicle is still tied together until you're eight and a half minutes into the flight, and there was a jolt to the whole system when the dynamics of the solid rocket boosters started dominating the response frequencies of everything. Some of the dynamicists thought the loads that had been predicted when it was still attached were enough to break the joints. That quarter-scale model had to be tilted at 13 degrees to the horizontal. As you leave the [launch] pad and you start curving the line of flight downrange, the tilt on the external tank became 13 degrees.

When we built these things we didn't have any tooling, so some of the joints were not really top-notch smooth and linear. There was one location up near the forward quarter of the external tank where the real life article had its lowest margins of safety, right where the joint is attached to the other elements. When we built it in our facility without any tooling, there was a big welding step because the two welds didn't line up properly. Okay if you don't test it structurally, but this was going to give it a real workout. One good thing about pressure vessels—if you got some worries analytically about buckling, then if you put some pressure inside the tank it rounds it out nicely.

I went to see Bill [William H.] Frohoff and I said, "Bill, we got to change our test approach."

He said, "What do we have to do?"

"While we run that tilted test we need to pressurize the external tank."

He said, "Pressurize it? We never talked about that before."

I said, "I know. Well, we never built it before."

I don't think he told anything to NASA, just, "We've decided we're going to pressurize the tank. That's more realistic." We did 13 degrees tilt, loaded it up with water, ran the test, everything came through just fine. Six months later they had the real full-scale articles in the laboratory at Huntsville [Alabama, NASA Marshall Space Flight Center], and during a structural test they got a big elastic buckle in the external tank. Bill Frohoff's telephone started to ring, "What do you guys know that we didn't know?"

The program was successful. I think the four elements had been on loan somewhere. The orbiter loan is expiring. It'd really be a good attraction.

SECHRIST: It's actually up in Canada in an airport lobby. When that expires, we want to try and get it down here.

WRIGHT: Maybe you can see it again. It's been a long time.

EMERO: It's been a long time, yes. They had the elements stored at JSC [NASA Johnson Space Center, Houston, Texas] for quite some time. They thought they might use it for some payload tests, but I don't think that ever happened. It was interesting, a different kind of experience.

WRIGHT: When that project concluded, where did you move into next? What area for the orbiter?

EMERO: About the time that had concluded, the stuff hit the fan on TPS [Thermal Protection System] development. For the first time NASA was asking a contractor to provide a re-entry vehicle that had reusable thermal protection materials so you didn't have to replace them every flight. The heat shield on the Apollo started off six inches thick or so, heavy material that would ablate off bit by bit by bit and end up maybe an inch and a half thick. You couldn't reuse those.

NASA Ames [Research Center, Moffett Field, California] had been doing some development work on reusable ceramic tiles. You can make it lightweight at nine pounds a cubic foot. You hold a tile in your hands, it feels like a piece of Styrofoam [closed-cell extruded polystyrene foam]. If it didn't get damaged during the flight, then it could be reused. We developed repairs for various types of damage. The nine-pound-per-cubic-foot density material and the 22-pound, those materials seemed to loose adhesion to the strain isolation pad (SIP) at less than the basic material strength when you tested them. When we ran hundreds of tests, the results scattered all over the place. So the company and NASA decided to put together some tiger teams.

Each tiger team was given a task to come up with a solution to this problem on the tiles. I got assigned to a committee to investigate the extreme variation in the test results. We had a bunch of sharp guys on that committee. The answer was that the SIP, Strain Isolation Pad, and the bottom of the tile were incompatible with each other from a stress concentration standpoint. The SIP is essentially a continuous medium with lots of fibers going vertically to take those loads, but only 10 percent of the time could you find one actually attached to the SIP. So all the load paths became classic stress concentrations so they failed early.

I just explained that in a few words, but it took a lot of thinking to come up with what might be going wrong. By the time we understood the problem, we had already delivered [Space Shuttle] *Columbia* [OV-102]. We had all the tiles installed, and during that flight down there some tiles dropped off. When they asked me I said, "I'm in charge of the ones that stay on the vehicle. Some want to leave the vehicle, that's their choice." I got a few laughs but no raises.

After that discovery, things escalated really fast. I was invited to be a witness at the big meeting in Washington, DC [NASA] Headquarters. This is a major slowdown in the program and major cost buildup. Take them all off, reinstall them, make improvements where we needed to. The day after I got back—Sy [Seymour] Rubenstein had just been appointed the vice president of engineering. He called me into his office and says, “Who do you work for anyway?” I had come out of the structural analysis office and had taken a job for a short time on the external tank integration program.

I told him I was working on the integration of the external tank into the system. He says, “You’ve had it easy long enough. From now on you’re going to be my TPS project manager.” Sy would call a meeting at 4:30 in the afternoon. It would just go on and on. If anyone was there that needed to talk to Sy with a problem, he’d stay late until 7:30, 8:00 sometimes, every day of the week. It was a stressful kind of environment.

WRIGHT: Tell us how you were able to solve the problem.

EMERO: Since the SIP was essentially a uniform material for that purpose, it was doing its job just fine. What was wrong was there weren’t enough fibers in the tile material where you needed them, right at the bonded joint. So our M&P [Materials and Processing] brethren came up with a process. They used a paintbrush and some ceramics in solvents, and they would paint the bottom of the tile with the slurry. They were actually putting ceramic material into the last quarter inch of tile where it contacts the SIP. That’s called densifying the material. As soon as we did that, we ran the same tests and we started to consistently develop the full strength of the tile material.

WRIGHT: Were you and Rockwell under pressure to get this answer to these tiles from NASA?

EMERO: Yes, the simple answer is yes. The tiles weren't prepared properly to be bonded to the SIP and thence to the structure. In the early days there were something like 32,000 tiles on the vehicle, and essentially all of them were on there when we delivered it to Florida [NASA Kennedy Space Center]. Going to Florida had been delayed once already, and they had already hired hundreds of people to work on the Shuttle. They kept saying, "Send the vehicle, send the vehicle, we got the people, send the vehicle." That kind of pressure was on.

"We can't send the people because they've been trained in the wrong process. We need to train them properly and then we can send them down there." Every day added cost to the program and schedule slippage; the kind of thing that can ruin your career. I did that job, project manager for TPS development, for six to seven years. One day Dick Thomas came into my office and said, "I've been remiss in overlooking you, Don. I should have promoted you out of this job a couple years ago. Somebody wants to hire you as a deputy program manager."

Bob [Robert M.] Glaysher on the operations contract was looking for a deputy program manager because he was in fact managing two contracts: the operations contract, and we had just won the contract to provide the logistics spares. Dr. [Rocco A.] Petrone gave him control of both of those programs. Logistics was big dollars because it was the first time NASA had to buy spares for their vehicles. If you don't catch the production line and you reopen it—time, money. They had to be in a big rush to order to meet the production schedule so they could get better prices and better delivery schedules. Yes, it was pretty hectic.

WRIGHT: Did you take that deputy program manager job?

EMERO: I sure did, it was executive payroll job. It was a little odd in that in just a few years I went from an MTS-5 to a program manager.

WRIGHT: When you were working for Mr. Glaysher, part of his work was the logistics for the spares. Could you talk more about the importance of NASA having those spares available for the orbiter?

EMERO: With four vehicles, it was obvious we were going to need a logistics support system. The ideal way to do it is when the prime contractor is building parts for the vehicle, make one more and you get a good price. But if you miss the closedown of the production line by six months, you will pay for that startup cost and the time lost. So ideally when the vehicle is being designed, logistics will have an opportunity and the money to order those spare items that they believe they will need. Not everything is needed for spares, because some companies make products that are very similar and you just could qualify the similar part.

For NASA and for the contractor it was all a new game. We got a really good program director of logistics, came from Autonetics [division of North American Aviation]. Jack Cassidy was his name. In fact Jack knows a lot about logistics and how to run a logistics program, so he hired in the right guys and the logistics department went from one or two people to hundreds. Later on, the responsibility for that work was transferred from Downey to Kennedy Space Center, which is the right place for it.

WRIGHT: Were you involved under the operations as well?

EMERO: Bob Glaysher told me, "I really want to spend my time on the operations side, but the logistics contract takes too much of my time to really keep abreast of everything on ops [operations], so I want you to become 'Mr. Logistics.' You spend 80 percent of your time on logistics and 20 percent of the time on the Shuttle." It worked out fine.

WRIGHT: What challenges did you have in that position?

EMERO: The logistics—mostly spares, spare units, and repair capability, repair depots—they all become an integral part of the program because they support each other. You can see the logic of being involved when the production line is still running, because you get a good price and a good delivery schedule. Like many other things, NASA doesn't have enough money for everything it wants. The thing that seemed to suffer a lot was the logistics program.

WRIGHT: As a contractor, did you make suggestions to NASA for what parts they needed?

EMERO: They had a logistics board, and we had to convince them or their underlings when we needed to buy "five of those widgets." "What do you mean? These things are very reliable, they're not going to fail." They'd get into discussions like that. There was always pressure on to keep the cost down, and you could do that if you could look ahead far enough and make some orders of equipment where the production line was going to be shutting down in the foreseeable future, and that saved money.

WRIGHT: You were promoted to the position of orbiter chief engineer. How did your job change and what were your responsibilities?

EMERO: The way that Rockwell manages their programs is that the contract comes in, and a program manager is defined. Rockwell has a project office, and a project engineering manager is assigned to every task that's in that contract, Mr. or Ms. Get It Done. It starts off like when I got the TPS job, I had to start from scratch. I called a meeting of all the disciplines—all the design, analysis, thermal, heating, aeroheating—and laid out the tasks and who was going to run them. I'd change it during the meeting if I thought it wasn't right. Asked them for a schedule, and what your organization looks like and how big it's going to be because we got to make sure you got budget to get your job done. For the TPS folks it was a brand-new world because they'd been working on development contract for a long time.

When we developed the thermal blankets, it was under winter conditions in southern California. Weather isn't really bad, but the contract required that you put some of this material outside in the open air to get rained on and thunder and lightning and birds and so forth. It had to be out there for some period of time, and they would send a technician up to the roof about once or twice a week and he'd note all the conditions. It was performing very well, until one day the technician came back from the roof and said, "There's some fraying going on there."

We said, "This material doesn't fray. It doesn't wear out either; nothing to cause it to wear out. Well, go ahead up tomorrow, see if it makes any change."

"Yes there's a change, getting worse."

"Something funny going on here. Let's put a camera out there, record what's going on. Maybe some animals are on it."

It wasn't animals, it was birds, birds who discovered that if they used the most beautifully developed and warmest insulation material that they could find, they would have a really comfortable nest. What they found was our insulation material for the Shuttle. After a few days of that, the blanket was gone, lining all the nests around there. We had to take the nest and move it somewhere else.

SECHRIST: George Holt developed those processes. They would go down and demonstrate it the first time while I put the course together. I taught all of that tile repair, including the trepan cutter making plugs. Then when densification came along it was the same thing, and you had to sign these quickie travel authorizations for me to get on the airplane and get someplace so that they would stay up to speed. Your secretary would just bring them in and say, "Sign here."

EMERO: People don't know the extent of the effort that went into creating repairs to tiles.

Kennedy Space Center just happens to be on the eastern flyway—birds leave the northern territories and go down south there for the winter. It's approaching springtime, so they all want to build a new nest for the little chickies that are coming along. The first three vehicles that went out to the launch pad, all the elements—the boosters, the tank and the orbiter—were painted this gleaming white color. NASA was always looking for weight-saving campaigns. The external tank guys told them, "Look, you got a big weight saver on the external tank project. Just leave the paint off the insulation." The insulation that's on the outside of the tank is there to keep the stuff on the inside cold, because if turns into gas it's gone. NASA decided they weren't going to paint the insulation, and the insulation material is not unlike bark in texture and color.

Every woodpecker for miles around thought heaven had just arrived in the form of this gigantic tree. Huge, 30 feet in diameter. You could peck a hole in that thing in ten minutes, really soft stuff. They could go in about four and a half inches—that was the thickness of that insulation—then they'd run into something really hard. Not discouraged, they'd back out of that hole, move over a little ways and start again. So all over the external tank these holes started appearing. Whistles and horns and all kinds of noisemaking devices didn't scare them away, couldn't get rid of them.

At the Cape they always have had an active program fostering a positive relation with the wildlife down there. Suddenly they want to get rid of some of this wildlife that's damaging America's space hardware. Finally someone who knew something about birds told them, "Forget those horns and stuff. Traditionally owls have been used to keep woodpeckers away." Over the eons the woodpecker would begin a good size nesting hole, and then the biggest owl around would come over and muscle his way in and take over. They don't like each other. "Get yourself a stuffed owl."

That sounds easy enough, but where do you get stuffed owls anyway? Got to go to some store that specializes in taxidermy. Somehow they found an owl and brought it out to the launch pad and wired it to the fixed structure there. It was just far away at the top of the pad such that when the vehicles lifted off they didn't burn the owl. That kept them away, the woodpeckers never came back. Unfortunately that owl had been made out of materials that were never qualified to be used on the beach at Kennedy Space Center with the tornadoes and hurricanes and rain and hail. I think it lasted about five or six flights, which was amazing.

Here's the owl all blown to smithereens, just little feathers left. The guy in charge of the launch pad sent one of his guys, "Go over to the logistics spares warehouse and get a spare quick." So the guy goes over there checking around. "If there is one in spares, it's here. All I need to know is what's the part number." Part number for an owl? It didn't exist. They had to go find one, they didn't have one in spares. That's the story of how Mother Nature almost brought America's space program to a grinding halt.

WRIGHT: You received a Distinguished Public Service Medal. Part of the recognition was for your leadership in developing engineering solutions for various complex problems involving the orbiter, thereby enabling NASA to maintain critical launch schedules. Can you share a few more examples of some of the other engineering solutions?

EMERO: I was chief engineer, and the way NASA liked to work with the contractors, their chief engineer and the contractor's chief engineer become a dynamic duo. Phil [Philip C.] Glynn was my counterpart. He's a hard guy to satisfy but he knew his stuff, I always admired him.

Any time a vehicle or a piece of equipment—APU or electrical system generator, whatever—if there was a failure either on the vehicle that was in orbit, that had just landed, that was being tested somewhere, NASA wanted an instant solution applying to all. Might not be the same fix, but they wanted to know how do I solve this problem and make the vehicles and the hardware ready for use in space.

The job was largely to support the logistics program, make sure we were buying the right stuff and define the testing program so we could test it before we received it officially. It was a big integrated system. I had a lot of traffic to Houston and the Cape [Canaveral, Florida]. The place I used to like the most to visit was Kennedy Space Center, always seemed to be something interesting going on.

WRIGHT: Do you recall any last-minute solutions to problems that you needed?

EMERO: There was one that was particularly interesting. Once on orbit when they opened the payload bay doors they pulled loose some inadequate bonds under the strips of the seal that goes between the payload bay door and the structure. There's a long beam that runs down both sides, and that beam then presses on some materials, and that's how you seal off the payload bay.

SECHRIST: They call that "monkey fur," that fiberglass that's standing vertically.

EMERO: We opened up the payload bay doors and these seal pieces are sticking up all over the place. The threat was [the payload bay doors] are not going to close properly with the seals missing in some places, interfering with the latches in some places.

I found the designer for that insulation, and that guy worked day and night. By putting points on drawings as he simulated the opening of the door, he could visualize what the seal was going to do when you tried to close the payload bay doors. He came up with an answer that in all the locations except one, the closing door will sweep that misplaced seal out of the way and it won't be in any region where it'll interfere with the latching. Except one place right at the top centerline doesn't come closed, it just barely touches. There this seal is going to get pushed right into the U-shape of the latch.

Everybody goes, "Oh no." You got to close those doors, or you aren't going to come back alive. So the designer told me, "There's one good chance that we will be able to close the door. Only got to close it once, never going to open it up after that." The U-shape half of the latch has got a roller, and this thing here has got a tulip kind of design [demonstrates]. When the roll hits there, it rolls itself down and compresses an internal seal there.

It was designed that way, such that when it ever had to push a piece of the seal into the U-shape of the structural seal, they put a short inch-and-a-half-long straight section. Added weight—normally we don't do that, but some smart guy got that done right. He says, "On that top centerline it's going to get pushed in past the point where the latching physically takes place, the rollers contact, and there's enough room to push the seal right where it belongs, and the doors will perform properly."

SECHRIST: It was a real concern for that mission.

EMERO: Oh yes. We gave them a major briefing. They asked a lot of questions, especially the astronauts. We told them, "It's okay to fly, but don't think you can open and close the payload bay doors more than that one time. Just close them, don't plan any more exercises outside." When it came time, the Mission Support Room was chockablock full of people. They gave the command to close the payload bay doors, and as they closed in sequence there's a feedback showing you which latches are closed and which are still open. One by one, they all turned green.

That was such a bold declaration. Most engineers won't go out on a limb like that and make a prediction it's going to work. But what else could you do? Just give them the best answer you got. This man worked day and night to come up with data, and the data said it's going to work. Kennedy Space Center management were so surprised, they had a technician remove the access door to the midbody and take some pictures of what each latch looked like.

Guess what? It looked just like the way the design guy predicted. Thank goodness we had him around. I got some credits there, but all I was was the spokesman.

WRIGHT: Mr. Emero, you worked on a paper that was entitled "Vision 2000: Shuttle Flight Element Modifications for More Effective Utilization." Can you give us some background about why you wanted to put that paper together?

EMERO: This was published in '93, and I retired in '94. Ken [Kenneth E.] Lengner [coauthor] was a project engineer in the project office, and he had these ideas about different ways to process the elements.

WRIGHT: It talked about utilizing the database hazard reports to come up with different ways to do processing, about accepted risk and how to reduce operations cost.

EMERO: Before the vehicle actually got to the Cape the first time, they had their flow planned for the way they were going to fix all the problems on the vehicle. They're going to use spares, take something off and repair it, [or] they're going to take something off another vehicle and "cannibalize." He had some thoughts on that and he wanted to have a technical publication. The AIAA accepted that, and he went to the conference and presented the paper.

WRIGHT: It also said that you participated in the *Columbia* [STS-107] accident investigation.

EMERO: There was a *Columbia* Accident Investigation Board. They had a dozen top level engineers and scientists from around the country. They were the official group. Of course each one of those men or women needed some support, so that’s the part of the committee I was on.

SECHRIST: You were called into the MSR [Mission Support Room] within hours of the incident, and then other things led to this position.

EMERO: Yes. As chief engineer you just had to be prepared to do anything anytime.

WRIGHT: Were you also involved with the follow-up after the *Challenger* [STS 51-L accident] in ’86?

EMERO: For any major changes I was, but I can’t remember if there were any.

WRIGHT: Briefly you mentioned that you had worked on the external tank integration before they pulled you over to do the TPS.

EMERO: That was a contract with Rockwell to build this vehicle to go into space. It had two pieces coming from Thiokol in Utah, the boosters. The external tank came from [NASA] Michoud [Assembly Facility], [New Orleans] Louisiana. They have electrical interfaces and several joints. You think, “Well, just put a bolt in there.” But you get some close tolerance design problems in those joints. You have to have a specification to define where this major interface will be, how is it going to be cinched up, and for how long will it be locked together.

All those things are handled by an integration contract. These vehicle elements are going to be integrated into the total Shuttle system. That was done at Rockwell here at Downey. They had the specifications in the form of drawings that would define what this interface looks like. Most of them required special bolts that could be sheared off when you no longer want to keep the vehicles together. I worked for a couple months maybe on the integration contract for the external tank. That wasn't bad, because I got to go to New Orleans [Louisiana] on my trips.

WRIGHT: Did your work bring you to Houston to the Johnson Space Center as well?

EMERO: I traveled a lot for meetings to Kennedy Space Center. Two weeks before every flight NASA convenes a major meeting at Kennedy Space Center. It's called the flight readiness review, where everybody involved in small or large ways on the flight, they all have to say they're ready to go. It's all recorded, and all the program managers there have to sign off on their responsibilities.

The [Launch Control Center], first time I went in there I saw that the windows were not vertical, they were tilted inward towards the room because that room is like three and a half miles from the pad itself. If there's an explosion they don't want that blast wave to come and hit a glass window that's straight and normal to the force, so they tilted it so they get some to bounce off.

I used to like to go into the Shuttle hangar, Orbiter Processing Facility. The first time I walked in there, I'd been anticipating that walk. I come into the door, and I couldn't see the orbiter. It was all surrounded by the tooling and the stepladders because they have to be able to reach every square inch of the surface of the vehicle to repair or replace the insulation material. I remember how disappointed I was, "I can't see it."

WRIGHT: Our time is starting to come to a close. I wanted to ask if there were other memories that you wanted to share with us today about your time with the orbiter program.

EMERO: I always like to talk about the Shuttle, it's such an interesting project. Even today I still once in a while go into a classroom. Anything to do with space, doesn't matter how long ago it was. If I could, I would try to get an astronaut to come with me.

WRIGHT: Before I close today, do you have a special memory or a favorite accomplishment that you'd like to share?

EMERO: I'm wearing the two highest awards that I got. One of them is the Distinguished Service Medal. Most of the time we think of the Distinguished Service Medal as going to somebody in the military, but NASA has their own version of the Distinguished Service Medal and in the hierarchy of medals it's the third highest. I'm especially proud of that one.

Then the second one is the [Space Flight Awareness] Silver Snoopy award [presented by astronauts]. There was a belief in our company that if you were in any level of management you were not eligible for a Snoopy. Grant Hoage decided to go check into that one time because I told him, "One thing that I always wanted was a Snoopy, but because I've been in management just about all the time I've been here I can't." He didn't tell me what he was doing, but he went on a campaign to find out the facts. It turns out there's a maximum of three Silver Snoopys can be awarded to members of management, but there's the signature list you got to get signed and all the criteria.

I retired January 1st, and I received my Silver Snoopy just three or four months before that. Finally went through the system, had to go be signed off at all three Centers. They kept it quiet, nobody breathed any hints that this was going on. The astronauts came to present Silver Snoopys to those who had recently supported them in a flight. I started to walk over to the three or four people from engineering who had gotten a pin.

Bill [William F.] Readdy says, "Don, long as you're standing up, come on up to the front here." I thought maybe he wanted to take some more pictures. Once I got up there he said, "Well, now we have a surprise for you." The room had filled up somehow, the word got around and everybody was there. That's when they presented that Silver Snoopy to me. I saw Charles [M.] Schulz's [*Peanuts* cartoonist] workroom up in the [California] wine country, and the Silver Snoopy was featured on one wall. They really pulled a fast one on me. I was really proud of getting that award.

WRIGHT: I think it's a very nice award. Thank you for giving us those details today.

[End of interview]