

NASA STS RECORDATION ORAL HISTORY PROJECT

EDITED ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY REBECCA WRIGHT
DOWNEY, CALIFORNIA – AUGUST 25, 2010

WRIGHT: Today is August 25th, 2010. This interview is being conducted with Robert Kahl in Downey, California, as part of the NASA STS Recordation Oral History Project. Interviewer is Rebecca Wright. Thank you again for coming in from Palmdale [California] and meeting with us here at Downey to talk about this project. We'd like for you to start by briefly telling us about your career with [North American] Rockwell [Corporation] and [The] Boeing [Company].

KAHL: Prior to Rockwell I was working for Lockheed [Aircraft Corporation]. That program fizzled out and I needed a job, so I got hired on with Rockwell at Palmdale on the Space Shuttle program. [I was] the 107th person hired in at Palmdale for the program, with the understanding that we had about 18 months' worth of work. Here I am coming up on 36 years later still employed there on Shuttle. There are not too many people that can say they spent their whole career on one program or one project, but it's been extremely rewarding. I hired in there as a stock clerk working in the small stockroom warehouse, and progressed over the years. I'm now the site director for the Shuttle for the remaining effort that we have going on there.

WRIGHT: You were there at the very beginning of the orbiter builds.

KAHL: Enterprise [OV-101] was the first orbiter, and it was mainly just to validate the flightworthiness of the Shuttle as far as the Approach and Landing Tests [ALT] and things that

we did. People probably don't know that the Enterprise was originally named Constitution. For the couple of years that we were putting it together we never knew what it was going to be called. During the President [Gerald R.] Ford [Jr.] administration they were on a campaign to name the Space Shuttle, and he was a huge Star Trek [science fiction television series] fan so then it became Enterprise. It actually didn't get named and identified on the side of the vehicle until two weeks prior to rollout.

We first went to work there [at Palmdale Air Force Base Site 1 Plant 42 in California]. That is an Air Force site, and it had always been military. When NASA negotiated the lease in '72 for the Shuttle program, we started working and modifying the hangar to accommodate the Shuttle. If you look at a picture of the building, we actually had to raise the roof to accommodate the vertical stabilizer and the height of it to install it. We spent the first year just working on building, facilitating it to accommodate the hardware.

One of the major first pieces of hardware that we ever saw was the tires, and it was a big deal. We didn't have any other hardware but we had the tires. Probably the last thing you need, but it was the first thing we got. I can recall everybody making a big deal out of "Shuttle hardware arrives at Palmdale," and pictures and everybody getting all excited.

Then the components started coming in. The Shuttle is made up of a variety of components and modules from different subcontractors and whatnot. Of course the first piece of hardware we got was the mid-fuselage from General Dynamics [Corporation] down in San Diego [California]. Then came the wings. Downey manufactured the aft fuselage and the lower forward fuselage and the crew module. Then all the structure components and electrical components and black boxes. The vertical [tail] came from Fairchild [Industries].

It was pretty cool. We worked very very hard to get Enterprise put together, and then on September 17th, 1976, we took it to Edwards [Air Force Base] and prepped it for all Approach and Landing Tests on top of the [Boeing] 747 [aircraft].

WRIGHT: That was quite an event in itself.

KAHL: That was an amazing event. I think after almost 36 years the real heroes that need to be recognized on the Shuttle program were the pilots, the astronauts that flew Enterprise for its first separation flights. Because without validating it and taking it up to 40,000 feet, separating from the 747 and gliding it for the first time into the dry lake bed at Edwards—not knowing that it was going to glide, that the flight controls and the brakes were going to work and it was going to stop, and do all the things that it was supposed to do—the astronauts and the missions we've flown and the [International] Space Station is all great great stuff, but without that first ALT team and Fred [W.] Haise [Jr.], [C.] Gordon Fullerton, Bob [Robert L.] Crippen—those guys are the ones that really set the scene for the things that we continue to do today.

WRIGHT: Were you out at Edwards for any of the testing?

KAHL: I was at Palmdale for the whole duration of Enterprise build, and then we went to Edwards and facilitated Edwards. Built the mate/demate hangar and the facility to pick up the orbiter and stack it on top of the 747, for the whole duration of the ALT program. I've been engaged with every orbiter, every build, every modification that was performed, whether it was at Palmdale or Edwards.

WRIGHT: Like members of your family.

KAHL: Yes, the people that we worked with have just been incredible.

WRIGHT: It was quite an undertaking, just moving the orbiter.

KAHL: We used to transport it overland. We had a huge transporter that we would put the vehicle on and literally transport it down city streets. I can remember prepping the city streets prior to Enterprise's first trip down—used to be called Tenth Street, now it's called Challenger Way. We removed stop signs, streetlights, telephone poles, trees to make it wide enough to accommodate the width of the wings for a 35-mile overland trip out to Edwards.

I can remember that first day that we transported Enterprise. The people lined up on the streets. The nucleus of the public didn't really know what the Space Shuttle was or what it was going to look like. The oohs and ahs and the applause was—goose bumps, it was pretty amazing. Then of course the rest is history because everybody in the world knows the Space Shuttle and for the most part supports the program. So it was amazing.

WRIGHT: Were you part of the caravan?

KAHL: Oh yes, absolutely. I had a couple different roles at the time. One, I walked about the first seven miles. Then once we got out of town to unpopulated areas I rode in one of the caravan vans. It was amazing.

Then the day we hit Edwards we worked seven days a week, twenty-four hours a day around the clock, not only preparing the vehicle but preparing the facility. We were still finishing the mate/demate hangar and the lifting device, we hadn't even completed that. Then the 747 came in, and we had to validate the 747 and the attach points for the orbiter. The first time we picked the orbiter up and set it on top of the 747 was a huge event.

Then we did three or four taxi tests with the Enterprise mounted on top of the 747. Validated the brakes of the 747, and then we did some flights with it. The orbiter has a tail cone on the back which is for aero [aerodynamic] purposes. We did a couple flights with the tail cone and without the tail cone. We prepared it for the first separation flight. Obviously that was a huge historic event, the day that we in August did that first separation flight [August 12, 1977]. So yes, part of it all.

WRIGHT: Did you work with the teams out at Edwards, or did all the people come from your facility?

KAHL: A lot of the folks came from Palmdale. Some of the folks came from Florida [NASA Kennedy Space Center]. Then at the time NASA was the prime contractor, we had a lot of NASA folks both from [NASA] Dryden [Flight Research Center, Edwards, California], from Edwards, and then from Houston [Texas, Johnson Space Center] and Florida, that we engaged with.

As things grew, I grew. I became a supervisor, then a manager, responsible for a variety of things. When the program was over we came back to Palmdale and we all started working on [Space Shuttle] Columbia [OV-102]. Columbia was a totally different vehicle, because it was a

space-rated vehicle. Enterprise was just to validate the airworthiness of a flight vehicle and demonstrate that it could do the things as advertised.

WRIGHT: As you mentioned you came back, started working on Columbia. Had you previously started? Were there already components and [had] parts arrived?

KAHL: It was coming in, yes. As we were doing ALT, a lot of the components were starting to come in. We had a team of folks that were just receiving the components and placing them in the hangar and doing some work on it.

WRIGHT: Were your teams pretty solidified from Enterprise to Columbia? Or did you start to have more additions of personnel or replacements of personnel?

KAHL: At the peak of Enterprise we probably had 300 people. At the peak of Columbia we had at least 1,000. But it was a totally different aircraft. We were developing tile, we were installing tile. Enterprise did not have tile as thermal protection as a space-rated vehicle. It had foam tile which simulated the appearance of the real tile. Columbia had far more flight controls and instruments and components of a real space vehicle—the APU [auxiliary power unit] system, all the cooling systems for the LRUs [line/lowest replaceable units]. We had to install all that; Enterprise didn't have all that.

WRIGHT: Did you find one of the components more challenging as you were bringing Columbia online?

KAHL: *Columbia* was a whole lot more cumbersome to build because of all the added flight controls. I would say the thing that was the most difficult was the rudder/speed brakes and the vertical. Because Fairchild's efforts to build the vertical—and then when it came to Palmdale our efforts to install the rudder/speed brakes, which is speed control in the top of the vertical—the first time we did that was pretty sporty. The payload bay doors and installing the radiators was pretty interesting.

The thing that most stands out—there's miles and miles of wire and miles and miles of tubing that goes from one end of the orbiter, as in the crew module, all the way through to the aft fuselage. The aft fuselage structure where the engines mount, it's just enormous. We fit-checked a set of flight engines one time because [Pratt & Whitney] Rocketdyne Canoga Park [headquarters in California] wasn't far from us. We brought up a set of engines and fit-checked them in *Columbia*. That was a pretty historic event.

It's a huge forklift with a huge GSE [ground support equipment] set up on the end that we mount the engines to, and then you lift it up and put it in the rear of the orbiter. We validated all that at Palmdale long before it ever went to the Cape [Canaveral, Florida]. That was a huge event, a lot of folks involved. The first time you did something, there was a lot of folks engaged both from Florida and Houston, because the work would eventually transition down there. It was cool, it was good stuff.

WRIGHT: Were you implementing the components as well as training these people from Kennedy and JSC?

KAHL: Obviously it was a huge learning curve for everybody involved, from the engineers that designed it, from suppliers, the subcontractors that were building hardware components, to the techs [technicians] that we had that were installing it. You always have issues any time you do something for the first time. Collectively it was a huge team effort to validate something from an as-built to the installation standpoint.

I can remember the first time we powered up the vehicle and did checkout of the orbiter. It was huge, huge. You have instruments for the very first time, lights winking and blinking, flight controls doing what they're supposed to do, astronauts in the crew module, commanders in seats—going through flight test simulation was huge. Seeing landing gear retract and doors close and payload bay doors open and close like they're supposed to. That's pretty cool stuff, especially when it's doing it for the first time. It was very rewarding.

Then it became routine, because you knew it would work. You would just go through to the checkout mode, making everything operational, functional. Of course you had troubleshooting. Things don't work like they're supposed to, and then you go into a troubleshoot mode. Get the flight control engineers or the subsystem engineers, depending on whether it was electrical or hydraulic or flight controls. We had people come and stay forever. The one objective is to fix it, and fix it right.

The thing I think was most interesting is people at Palmdale had an unwritten agreement with the astronauts. That agreement was to do the best job they could, to give 110 percent, to make sure that it was the best orbiter vehicle that we could ever deliver because of their safety. What was really really neat is the astronauts that were assigned to the respective Shuttle lived at Palmdale, they were part of the team. They knew the people, the workers, by first name. Their job every day was to come in and be a part of whatever they were doing. They were engaged.

Go to a meeting, and they're in the meetings. They wanted to know what was going on, and they were just treated like one of the workers.

WRIGHT: 24-hour production?

KAHL: It was peaks. We tried to run it five days a week but the complexity of the program and the schedules, we worked a lot of seven-day weeks. We would do a lot of off-shift type stuff depending on what it was. A lot of schedule shift of people, could have first shift people working second shift or third shift because of their job and the need of the role. A lot of camaraderie, everybody just rolling up their sleeves and doing whatever it took. People would just come and stay in their motor homes [recreational vehicles] in the parking lot. We would have barbecues in the parking lot. People wouldn't go home, they would just stay there. It was not uncommon for people to work ten, twelve hours a day, go take a break, and then come back and go back to work another four, five, six hours, whatever was needed.

WRIGHT: Was this mostly on Columbia?

KAHL: All vehicles. During ALT testing out at Edwards during Enterprise, that was huge. I personally took my motor home out there. I was weeks in the parking lot and my wife would come and visit me. That's just the emphasis and the way everybody reacted to the needs and the things that were going on.

WRIGHT: There was a time that you had a number of the vehicles all in parallel that were being worked on. Can you share how that was coordinated?

KAHL: For example during the **Columbia** build we brought OV-099, which was **Challenger**, to Palmdale. I was responsible for doing all the ground vibration tests over at Lockheed, or “shake and bake.” We structurally tweaked the vehicle, and Lockheed had this huge facility across the runway where we did that. When we brought it back it became the flight vehicle. The structure was so sound, and the data represented that it was worthy of making it into a flight vehicle. So we disassembled it, brought components back to Downey, and they started working on the aft fuselage, lower forward fuselage, the crew module. We started working on the mid-fuselage and the wings, and turned it into a flight vehicle.

So we had two orbiters at one time. We brought **Columbia** back after it had flown three or four missions and did what was called a mini mod [modification], a AA [double A] mod. Basically it did some weight savers, removing of some hardware. The **Columbia** originally had ejection seats in it and we took the ejection seats out and reconfigured the vehicle with different flight controls, had a lot of instrumentation wiring that was no longer needed. From a weight saving standpoint we removed a lot of wiring.

At the same time we had **Atlantis** [OV-104] going through buildup. So there was a period there that we had **Challenger** [OV-099], **Discovery** [OV-103] and **Atlantis** in and out of Palmdale in parallel with the orbiter modifications which **Columbia** did in '85. Then as we got out of delivering **Atlantis** we were in a down mode, because originally **Atlantis** was the last vehicle. A lot of the workforce went to the B-1 [bomber program]; it was ramping up. The nucleus of our workforce was able to just go across the runway and stay employed.

Then after the Challenger episode [1986 STS 51-L accident] we built Endeavour [OV-105] to replace it. Brought the whole workforce back and went into building and assembling the Endeavour. As the program progressed [and] Endeavour [was] delivered, we became the center for OMMs [orbiter major modifications], did that for quite a few years until it transitioned down to Florida in 2001.

WRIGHT: Talk some about the modifications and how that was different than the original builds, and how you were able to upgrade and update the different orbiters for what they needed.

KAHL: I look at it like a race car. You always want to go faster, you always find a way to improve things. The modifications to the orbiters were mandated based on the mission needs. To be able to do an extended mission we had an EDO [extended-duration orbiter] pallet, which we put in the aft of the fuselage that would take on more tanks to allow the orbiter to stay up for 21 days. We modified the vehicles with instrumentation and wiring and plumbing so that it would tie into the existing systems to, when needed, put the pallet in to carry longer payload and stay up longer.

Thermal was always huge modifications. The thermal protection system was always advancing to something new. We replaced tile with FRSI [felt reusable surface insulation] because thermal characteristics showed that we could use a different felt material and it would also act as a weight saver. We did a lot of thermal protection upgrades over the years. Almost every orbiter modification that we did to every vehicle encompassed thermal type modifications and upgrades.

All the LRUs would always go through a series of software upgrades and we'd have to pull all the LRUs out. A lot of the components, like the APUs, would come out and go back to the subcontractors for upgrades. Nosewheel steering was huge modifications. The drag [para]chutes—to be able to land on the hard runway in Florida we did the design and the development and installation of the drag chutes on all the orbiters. That was a huge mod.

WRIGHT: If you can talk about the drag chutes. Were you very much involved with the manufacturers as well? You said you designed them here.

KAHL: Yes. Downey did the design, and we worked very close with the design engineers, not only building the hardware but making recommendations on what we thought would be a good way to install it. Drag chute has a jettison mechanism in the back so we worked very close with them on the design of that and location of that.

We always had engineers from Downey at Palmdale. They worked with the techs as if the techs were engineers. They valued their input, they didn't treat them like they were just a tech. They used suggestions and recommendations. A lot of times the techs were very instrumental in design changes or fixes or repairs because of their hands-on day-to-day activity. It was an outstanding working relationship. A lot of times we would send our techs to Downey to work with the engineers and vice versa they would come to Palmdale.

WRIGHT: You mentioned that the thermal protection system was always being changed and enhanced, improved. But there were also some other elements that were added, for instance the

50-foot inspection boom [on Discovery]. That was added one time as a change or as a modification.

KAHL: Well, the MPLM [Multi-Purpose Logistics Module] arm has always been a challenge. The installation of that, where it mounts inside the mid-fuselage among the upper sill longeron, the first time we installed it and fit-checked it was pretty sporty. When we deployed it, it was an event in itself. We worked during some of the enhancements for return to launch with the MPLM and using the arm to do the inspections on the vehicle.

We worked very close with the engineers on redesigning that whole pedestal that it mounts to so that it could have more movement. Then we worked very close with the contractors on the hardware. I even had techs going to Canada working very close with some of the issues that they were engaged with. That was pretty good to help that return to launch initiative for the things that needed to be modified and upgraded for the arm. We were very engaged with that.

WRIGHT: Unfortunately you had two time periods where you had preparations for return to launch. Can you share what the impacts were on your facility when the fleet basically stood down?

KAHL: When Challenger happened the nucleus of the workforce was over at B-1. They were devastated of course, like everyone else. But I think at the time when [2003 STS-107 Columbia accident] happened is when we really felt the impact from the people because of the loss. Not that the loss was any different than Challenger, but I think it was the way it happened and [more]

people were viewing it on TV. We had a lot of folks get some counseling and assistance during that period to help them.

We had most of the Palmdale workforce engaged with supporting the investigations. We had rooms set up, had folks from Downey and Huntington Beach. I brought folks back out of retirement. Engaged with the investigation, supporting the investigation. We worked six, seven days a week sometimes, a lot of hours, helping with the data that was required and pulling historical data out of archives and packaging it with the subsystem engineers. Reviewing the data and putting together and recapping the events that took place, and then sent that data forward. We were very engaged there for a long time with the investigation. I think that helped the workforce for those who struggled with what had happened, and it was a good thing.

WRIGHT: When you prepared the orbiters for return to flight in that in-between time, were you able to do additional modifications that you had hoped to be able to do to the orbiters while they were waiting to return?

KAHL: Yes. Every orbiter came back to Palmdale for two things. One was OMM, the orbiter modifications, and the OMDP [orbiter maintenance down period], which was more of an inspection of the vehicle. As we did the structural inspections of the vehicle knowing what areas we had to go into to access to do the structural inspections, we would incorporate mods at the same time. So we did a lot of upgrades based on the investigation and recommendations for return to flight, as well as validated the structure of each one of the vehicles for corrosion.

Corrosion has always been an issue. The elements in Florida really invoke a lot of corrosion, so we would validate the structure and do some repairs where needed. Some of the

mods were very lengthy, some of them were very short, just depends. Once an orbiter came back for maybe its second or third time there was less mods to do, so the majority of the work was doing OMDP type inspection type structural validations. Probably the biggest mod we did was the glass cockpit, the multi [-functional electronic] display system [MEDS]. MEDS was huge. We literally gutted the crew module and put in whole new flight controls, which was really really cool stuff. You power up the vehicle with whole new flat screens, touch screens. Especially with the astronauts who were assigned for that next mission being there, it was cool.

WRIGHT: It must have been exciting to watch it transform.

KAHL: We would have what we called power up parties and/or delivery parties. If we did something significant, like a huge milestone in the program, we would host onsite pizza parties and lunch parties and just shut everything down, feed the guys, and tell them thanks for a good job.

WRIGHT: You've mentioned a couple times about validating. Could you pick something out and give us an example of what the process was to have to validate to make sure it was ready to go?

KAHL: Our job, from a Palmdale standpoint if we built it for the first time, prior to delivery, was to validate all the systems in the orbiter. We could actually fly the vehicle in the hangar. We'd do a full functional checkout. We would validate all the systems, whether it be flight controls, whether it be power to APUs, run the landing gear, run the elevons, run the body flap, validate the actuators, the speed brakes and the vertical. We would do a preflight and validate all the

systems prior to delivery to Kennedy. Then Kennedy would go in and install the engines and some of the hypers [hypergolic fuel systems] and go through a validation. We would check out the entire vehicle and then fix any anomalies that we had and try to deliver a flight vehicle ready to go, put gas in it at the Cape and launch it.

That is a huge task in itself, because a lot of them were vendor parts. So you're constantly pulling stuff, sending it back to the vendor. They're troubleshooting it, then it comes back in. You put it back in, you go back into a checkout mode. A lot of it was constantly juggling schedules so that you could continue to do other things and then go back into testing that component when it came back in and rescheduling those activities. Sometimes off shifts, off hours or on the weekends, whatever it took to deliver and maintain schedule.

WRIGHT: How did the evolution of different types of technology assist you in your job?

KAHL: Well, it was a learning. The cool thing is that we were part of it. We were part of something that was designed in the '70s, and then through the '80s things changed and through the '90s technology changed. We were part of incorporating that and/or making inputs to changes as things developed. That was the cool thing.

All the subcontractors involved that built various components and pieces of hardware—as things changed they were making changes to their hardware, which meant we had to go change the way their hardware talked to the hardware in the orbiter. So we had to go make modifications to the orbiter. Whether it be electrical wires or plumbing, we may have to go replumb something to hydraulic changes. I think it was excellent because it's an evolution. That's the whole thing about Shuttle. When you think about it, today it's still technology one of

the most advanced flying machines we've ever had, and it's still flying 35 years later. And should still be flying for many years to come, but we ain't going to go there.

WRIGHT: It sounds like things worked so well, and [were] so well orchestrated, but you also mentioned that you had to do some troubleshooting. Are there some examples that stand out in your memory?

KAHL: I can recall we couldn't get the landing gear to work. Engineers and our guys scratched their heads for days. It was a valve, but it was a valve that was not supposed to be a problem. It turned out to be a real problem. Probably the biggest troubleshooting issues we had were LRUs. The LRUs are computers, and the software in those computers sometimes didn't play with the systems that they were supposed to. IOPs [input/output processor] and GPCs, general-purpose computer, a lot of times didn't like to talk to each other. That, early on days, was the most frustrating.

Even during the ALT days, the flight controls we had out there were [the] first wave computers that had ever been used. We must have pulled those computers 100 times. Every time we had a problem we had to pull the computers. They would go back to Ham [Hamilton] Standard or Sundstrand [Corporation], the vendors. But it was part of it. When you're developing software to do things that a human would normally do, that's an evolution.

WRIGHT: Schedule—how much did it impact on how you made the decisions to move things in and move things out of your operation?

KAHL: We did things real time because the facility wasn't facilitated with a whole lot of room. So as components became available—like the mid-fuselage came in, we had to go right into the bay and set it up. The wings came in, we had to go right into the station for the wings and get the wings positioned to go in the bay. Aft fuselage came up from Downey, it had to go right into the mate station to get mated to the mid-fuselage. Same with the lower forward fuselage or crew module. The assembly area was also the final assembly area, and it was the mate area. Payload bay doors, when they would come in from [Rockwell Tulsa], we had a work stand to put them on because the next thing they did was get installed. So things had to be scheduled in a way that you schedule them when you're prior to installing them or need them.

Same with hardware. All the hardware that Downey built down here for us, we actually stored the hardware down here and then brought hardware to Palmdale as the schedule need was in advance. We kept the real estate up in Palmdale for the hardware that we needed and warehoused it all down here. We had a lot of scheduling shuffling. Scheduling was a huge activity. The finance guys and the scheduling guys and logistics of all of it was a day-to-day operation and communication with vendors, suppliers and of course Downey.

WRIGHT: Tell me about your evolution within the program. You've talked about the orbiters and you've talked about mods.

KAHL: When I hired in, I hired in as a stock clerk, and then a year later I'm out at Edwards as a supervisor on ALT. I got responsibilities that I didn't think I would ever have. We just continued to grow with them as the program grew. I came back to Palmdale, had a team called production control responsible for all the hardware. Then that migrated into owning the

procurement guys and then having all the scheduling folks. The next thing I know I've got all of that along with the finance guys. Then I got all the engineers working for me. Then I've got the thermal guys, all the tile guys, working for me.

As things grew, you're a family, and people would work together. Didn't matter who you worked for, what mattered was how you integrated the different skills so that they could all work together. As the program grew we all grew together, and people adapted to roles and responsibility very very good. We had some great synergy with the different disciplines of techs and interfacing with their day-to-day tasks.

WRIGHT: Did your jobs take you down to the Cape and to the other [NASA] Centers as well?

KAHL: I've been to the Cape quite a few times, not from a work standpoint. Whenever we would deliver an orbiter, my job was to go down to the Cape and go through a turnover review, recap all the activity on the vehicle with the different subsystem engineers at the Cape what we were handing off to them. Sometimes there were squawks that we just ran out of time to fix. I would bring whatever folks were needed down there to help them understand the squawks.

Then as the program grew what we started doing towards the tail end, especially through the OMM stage, was we would bring those folks from Florida to Palmdale. We'd bring them in for like the last two months of prepping the vehicle and testing the vehicle. So they were engaged with the things that were going on and far more knowledgeable. Once they got back to the Cape they could go right to work.

WRIGHT: You found that to be of benefit?

KAHL: Oh, outstanding, yes. We had an excellent working relationship with Rockwell and then it went to Lockheed, and obviously evolved into USA [United Space Alliance]. Still today we work very close with them. They still look at the folks at Palmdale as part of the team. They haven't forgotten us yet.

WRIGHT: That's good. How are you involved with the retirement?

KAHL: In 1972 when NASA negotiated the lease with the Air Force up at Palmdale, at Air Force Plant 42, the lease agreement was such that when NASA was done they had to put the facility back the way they found it. Over the 39 years NASA has had the lease with the Air Force, we've made a lot of changes to the site. I've removed roughly 15 buildings, and doing refurbishment to the buildings that are staying, and prepping the site for October next year to terminate NASA's lease and give it back to the Air Force. We've had a working relationship with the Air Force and NASA to transition the site for retirement back over to the Air Force,

Huge task left to do for next year is the actual Shuttle hangar itself. All the facilitation things that we did from work stands to integration of test consoles, next year our whole task is just to go gut it. The way the lease agreement is, you have to strip it back to four bare walls. We have a machine shop and a tank farm and we will be demoing [demolishing] those next year to hand the keys back over.

The only thing that they don't want us to do is where we raised the roof; leave the roof, that's fine. The overhead cranes and those things that we put in, we don't have to do anything with that. But for the most part the facility is being gutted and put back the way it was in 1972.

The reason is the Air Force has a need for an empty hangar, because there's so many programs at Palmdale relative to Lockheed and Northrop [Grumman Corporation] and Boeing that need hangar space for aircraft. It's not real accommodating right now to put an aircraft in, or multiple aircraft. That's why they would like us to take it back to the bare walls.

We've got to demolish the center work stands.

WRIGHT: Will those be broken apart for other [uses] and passed on or will they just be terminated?

KAHL: No, it's just huge steel structure type work stands. They'll be cut up and hauled off to scrap metal. Just like we did with the orbiter lifting fixture. The orbiter lifting fixture, originally Vandenberg [Air Force Base, California] was going to be a launch site/landing site, so the orbiter lifting fixture was placed over at Vandenberg, and then when they scratched that I brought it to Palmdale. We used it to support the delivery of Endeavour, and also all of the orbiters coming in for OMM. We'd be able to fly the 747 with an orbiter right into Palmdale, take it into the OLF [orbiter lifting frame] and then take it off the 747 and go right into the hangar. Then when we were done we'd take it back out, restack it on the 747 and send it home.

The orbiter lifting fixture became an icon because you could see it throughout the valley. If you were flying into Palmdale or up on a hill looking at the Air Force Plant 42, one of the huge things you noticed was the lifting fixture. A lot of people would say, "What is that huge fixture?" Of course when we told them what it was they would relate to it. But last year [we] cut it up, hauled it to scrap metal, it's gone. That's what we've been doing for the last four years, just transitioning the site to hand the keys back over to the Air Force in October 2011.

WRIGHT: You make it sound like it was such an easy thing to do to move the orbiter lift fixture to there. How did you manage to move that? Can you give some background on how you were able to transfer that?

KAHL: It wasn't easy. There was a huge effort to disassemble it at Vandenberg. Fifty-two semiloads of equipment and the structure we brought to Palmdale. Then about a 14-month effort to go facilitate it and erect it and validate it before we used it for Endeavour. Huge undertaking. Once again, the right people in the right jobs. We had dedicated guys we put on it. Hired one of the guys that worked for the crew that put it in Vandenberg to help us disassemble it, hired him to come help us put it back together.

WRIGHT: What kind of time period were you looking at to accomplish this?

KAHL: We did it all in 14 months. That was a huge task, because the footing that each one of the poles, uprights for the OLF—they were like 60-foot in the ground, and they were 8 feet around rebar. We not only built the rebar on the ground, then we had to crane them up in the air and put them down in the hole, and then pour the cement around them. That was a huge task. Multiple cranes to erect it and put it together.

WRIGHT: That was quite a sight to see.

KAHL: The sight was the first time we picked up the orbiter and unloaded the orbiter at Palmdale. That was a huge event not only for Palmdale, for everybody involved, because it was another historical evolution of the program. Now we could bring vehicles from Florida to Palmdale and send them right out of Palmdale, no longer have to take them overland like we used to transport them to Edwards. So that was a huge savings for the program and a huge event for being able to transport vehicles back and forth to California more expeditiously.

WRIGHT: Was it your idea to move that piece?

KAHL: No. Actually a very dear NASA friend Ed [Edward M.] Vonusa. Ed was the resident Downey guy but he was also responsible for Palmdale and at the time Vandenberg. He proposed when they were going to get out of Vandenberg—"What are we going to do with it?"

"Well, we've got room at Palmdale," and off we went. That was the right thing to do. The other thing that helped sell transitioning it, moving it from Vandenberg to Palmdale, was the community. The city of Lancaster [California] was continuing to grow. Twenty-some years later the efforts of transporting it down like we used to out to Edwards became more and more difficult because of the structure and housing and the community. That was an easy sell once we were transitioning into the OMM business. We actually had to go take a different route. Tenth Street, which is now Challenger Way, because of the buildings and housing we could no longer go that way so we were looking at other options. Then of course you would have to still go remove telephone poles and streetlights.

WRIGHT: It must have been quite a sight to watch the first to fly off.

KAHL: Oh, it was super. What's cool is Air Force Plant 42 is huge, and all our competitors are on the runway too. So when we would bring an orbiter and/or we were to deliver an orbiter, everybody—Lockheed, Northrop, everybody—was out on the runway watching what we were doing. It was always a cool thing. The whole world supports the Shuttle. I just think it's an amazing flying machine.

WRIGHT: It is, it is. You were in an interesting position because you were at Palmdale but you dealt with so many different entities, NASA and the contractors and of course your own employees. What types of communication systems or processes did you use? You were talking about the scheduling—how were you able to make sure that all the information got to everybody?

KAHL: I had a huge staff of people. We worked very close with the procurement organization and the subcontractors. Not only did I have staff that communicated with the respective subcontractors, but we also had schedule reviews with them to understand where their schedule position was for the hardware. Huge scheduling organization task to take the hardware that was being built in Downey to come to Palmdale. The subcontractor hardware that was being built all over the nation, sometimes that hardware got incorporated into the hardware that was in Downey coming to Palmdale, or straight into Palmdale.

We took the orbiter and broke it out by forward, mid and aft and then by components and subsystems. My production control staff would break out the hardware requirements, and then we would integrate that with the scheduling staff as far as our integrated schedule needs for when

we wanted to have the structure ready to accept the wiring, the plumbing and the component that plugged with it from the supplier and/or from Downey.

We had a huge integration of scheduling activities for all the components that went not only inside the orbiter but on the outside of the orbiter. Constant daily dialogue with subcontractors, procurement organization and the Downey folks down here. It was a huge task, never ending. We would have daily, weekly and monthly reviews. Every Friday I was in Downey for a program review with the hardware they were doing with us. Every Monday I had not only the Downey folks at Palmdale but I had vendors, subcontractors there, having program reviews with the visibility of their hardware needs and when I needed it.

There was constant dialogue of the build process. It was hectic and vocal at times. The thing about bringing everybody to Palmdale—I can't build it if I don't have the hardware. So they have a whole different perspective when they come to Palmdale and get a feel for your needs and they can take it back either to their factory or Downey and understand we got to get them this part because they really need it. Because they can see the big picture of the schedule impact when things don't come together as planned. Huge huge task.

When you look at what's encompassed to build an orbiter—thousands and thousands and thousands of pieces of hardware, from the nuts, bolts, screws, washers to the structures to the tile to everything it takes to build the vehicle. Huge undertaking. We did it, we did it numerous times.

We do the same thing with the modifications. We would take all the known modifications and integrate those mods just like we did from a build standpoint. We would take and schedule things in a way of disassembling. While you were disassembling and doing those

structural inspections we would integrate the mods, then test or validate the mods before we closed those bays back out to go back to the Cape. Another huge task.

WRIGHT: On occasion when you were working on the mods did you find areas that you or your technicians suggested to be modified?

KAHL: We would always find squawk areas where you would go in and something wasn't what it was supposed to be for whatever reason. You would come across a broken bracket or some structure deficiency, or you would find corrosion. Corrosion was a big deal, we would always find something corrosion-wise. You have to stop, go fix it, and then go back in and start incorporating a mod.

But that's what you were supposed to do. From the inspection standpoint that was a good thing, at least in my eyes, because you were finding things and fixing things to make it better. Then those same things for the next vehicle that came in or the next mod. Depending on the criticality, you would immediately go check it at the Cape or it would become an inspection or a requirement for the next one. There were a lot of good things that came out of doing OMDPs and the structural inspections because you were able to go revalidate things that you normally wouldn't go look at because you assumed it was working.

WRIGHT: How did the International Space Station impact your work on the orbiters?

KAHL: Actually it helped us. We had a machine shop at Palmdale, and early stages of Space Station they had trouble with hardware and we were low with work for our machine shop. I built

a ton of hardware for Space Station, over 10,000 parts. But the coolest thing that Station did for us was when we modified the orbiter for SSPTS [Space Shuttle Power Transfer System]. When the orbiter was docked to Station, orbiter could plug into Station and get power from Station to Shuttle, which was a huge modification and pretty sporty work. Then we modified all the vehicles for SSPTS.

Over the years they would need certain pieces of hardware and we had the skills and equipment, and they would come to us. Station was a good thing for Palmdale, it was great. When Station was in trouble our machine shop guys just rolled up their sleeves. They worked seven days a week, ten, twelve hours a day, whatever it took to help them get the hardware they needed to support their schedule needs.

I always like to refer to the guys as a seasoned work crew. They built the hardware. They either built it in Downey and then they moved to Palmdale or they were engaged with it from an assembly standpoint. If we needed a piece of hardware I usually had the guys go right to work on it, because they knew what they were doing. They'd been there, done that before. We were sometimes behind the gun because somebody needs something, they need it now, and they didn't know they needed it till yesterday or the day before. We were in reactionary mode, but that's where the guys like to be.

WRIGHT: You mentioned about starting to move the facility into retirement. Will you be working on preparing the orbiters in any way to retire them?

KAHL: No. Palmdale right now is done as far as supporting the vehicles. I have a few techs that do what's called tip/load and angle. Where the 17-inch disconnect on the orbiter side mounts to

the tank side, we do an alignment. My guys are the only ones that have the skills to do that and they're trained to do it, done it forever. Once we fly that last mission here, which I think is going to be June 28th, 2011, then those skills go away. I have about 20 folks left at Palmdale, and those are the folks that are for the most part supporting getting rid of equipment and the facility things that we have going on.

WRIGHT: It's quiet there now, isn't it?

KAHL: Yes. Five days a week, forty-hour-a-week job. I'm liking it, not too bad. I'd rather be building hardware and doing some cool stuff, but it's part of the wave to come. Houston is going to feel it, Florida is going to feel it.

I had a bunch of folks a few weeks ago, both NASA and USA and Boeing, in for a site review on the T&R [transition and retirement] efforts. I said, "I don't think too many people realize it, but you NASA have had this lease for 39 years. Over the four decades almost all the players have come and gone." The people that are involved with the transition don't have a clue what's taken place not only the last 39 years at Palmdale but the 35 years or 40 years in Florida and Houston, because all those people are gone. I think I'm one of the fortunate ones to say I've been here the whole career.

WRIGHT: You were there when the hangar door opened, and you'll be there when the hangar door closes. You've seen the whole life cycle there. Do you know of any others that you've worked with that you came in with or served with you?

KAHL: Actually I have a couple folks that have been there the whole time too. Our quality manager Gloria Castellano has been there the whole time. I just gave her her 35-year award. A lot of the techs that were there, we have them working other programs right now at Palmdale, the high desert we have for part of the Boeing flight test engineering community. We have 12 different flight test programs between Palmdale and Edwards, so I was able to move most of our workforce over to different programs.

We haven't laid off—very very few people. The ones we did lay off wanted to retire anyway, so that worked out. The nucleus of our workforce is employed doing other stuff. They're still around, I still have about 65 percent of my skilled workforce. I could bring them back if the program needed something. We're not totally out of business yet, but we're almost there.

WRIGHT: I want to see if there are some things that we haven't talked about that you'd like to talk about before we close.

KAHL: I think I've been a very fortunate individual. Do a lot of cool stuff for the community, very very involved with community and Space Shuttle. Go to grade schools and talk to kids about they should be an astronaut, give a lot of souvenirs away. Sponsoring here in a few weeks a Salute to Youth program with Lancaster and Palmdale and all the other aerospace companies up here. We bring in all the high school students and we have recruiting officers [for] the Marines, the Army and the Navy. Just try to motivate kids to turn off the headphones and get interested in something that's cool. We work very close with the Antelope Valley College. Jackie [L.] Fisher [Sr.], who's the dean [superintendant/president], gets really engaged with us.

There are a lot of great programs over there—try to get these kids to look at the next wave of Space Shuttles and do something.

I have been very fortunate to be a part of probably what will go down in history as one of the most amazing flying machines ever ever built. To be able to say that over the years the Presidents of the United States that came to our facilities, and celebrities—I talk to my grandkids sometimes and they're like, "Really, Grandpa?"—they're like 16 and 17. That's pretty awesome.

WRIGHT: Did you get to go to any launches or landings?

KAHL: Actually I've been to the Cape numerous times. I'm going to the next launch here in November [STS-133]. I've been out there for every landing at Edwards, because I still support the program. I go out there from the Palmdale standpoint, I bring skills and techs and stuff.

WRIGHT: Looking back on all these years, what do you consider to be the most challenging aspect of your role in the Space Shuttle program?

KAHL: Probably the personal side. You get so wrapped up in work and what you're doing. It's not your work and what you're doing, it's what it's going to do. I probably took away from family time back then worrying about building the Space Shuttle. That's okay, my kids are cool with it.

I think the astronauts are the coolest guys on Earth. They come in and they just want to be a part of what's going on. They buddy with the people, they have a lot of friends, they make

new friends. What was really neat is over the years as they would come back to Palmdale for whatever reason they wouldn't forget your name. I hadn't seen that guy in ten years and he remembered my name.

WRIGHT: That's amazing.

KAHL: That's the things that you look at, and you always value and treasure forever. There's Gordon Fullerton. Gordon Fullerton lives in Lancaster, and he is just an incredible man. We were out at Edwards, ALT, '77, '78; today I can see him and he's like, "How you doing, Bob? Haven't seen you in ten years." A lot of cool people at the Cape. You don't see them every day, but when you do see them they remember who you are and the things you've done. When I hang it up here in a couple years, that's probably when I look back and say, yes this has been cool.

WRIGHT: What do you feel has been your most significant contribution? What have you been glad you've been able to do for the program?

KAHL: I've always had an attitude, I probably learned it from my father—if you're going to do something give it 100 percent, if you're not going to give it 100 percent, don't do it. That can-do attitude. Over the years—and I think that's how I grew to where I'm at today—I didn't have a clue what I was doing, but somebody wanted something done I'd say, "I'll do it." Never did it before in my life, didn't have a clue, but I'd go figure out how to do it. My staff, it's "you call, we haul." It's like you know he's going to tell us to do it anyway so let's just go do it.

Even today, because I think it makes people grow. If you don't want to grow you're not going to excel. I would just give my guys more and more to do, knowing that they had the technical ability to do it, even to go figure it out. Just go do it. From the versatility standpoint, that's how Palmdale became very versatile in multitasking things and doing things.

We have a lot of union personnel. We were able to take a lot of classifications and consolidate them into a multitask classification because that individual could do multitask things. That was a huge struggle with the union. "You're displacing." I said, "No, I'm not laying him off. I'm just giving him more to do." Today we're still versatile in those areas, and we've taken it to other programs. I fought hard for that, and when the people want it, it's an easy win because it's their livelihood and their careers that you're saving and/or advancing to go do other things. We were able to multitask the techs in a skills mode that not only kept their job but it expanded their role. My philosophy is if I can build this and I can assemble it and I can put it together, why can't I test it, why can't I plug this cable in here or open this valve and turn hydraulic fluid on and why can't I do all that too? We won that battle. When you really really sit back and say, what have you done for the last 35 years, there's no way you can capture it all.

We had some terrific early Rockwell leaders. Bob [Robert G.] Minor, Rocco [A.] Petrone, Dan Brown. You go to school on their approach to things and their philosophy. Unfortunately a lot of those folks are gone. I was fortunate enough to work for people who pushed me to do more and gave me things to do because they felt I could do it. That's been my personal reward I think. "Give it to Mikey, he'll figure it out," and we do.

WRIGHT: Now having to close up shop down here, you must have some mixed feelings, watching all you built to go down.

KAHL: It's sad, but it's part of life, it's part of retiring. I tell my guys, "When we're done with this and you guys go retire you can say, 'I retired now because I retired the Shuttle.'" Just put a little different perspective on it. Change is good. I'm not sure retiring the orbiter is good, because I think we should fly them until we have something to replace it. When it's operational, then retire the vehicle. That's my personal two cents' worth. I think the program should fly these Shuttles for another four, five years or however long it is till whatever's going to replace it is operational and flown once or twice. Then go retire the vehicles.

I think you would see the astronauts and the whole program far more supporting that than the approach that's going on today. I'm an American—we don't ask nobody to do anything for us, we do it ourselves. That means we ought to fly Shuttle to support Station. We need to carry payloads up and carry astronauts up, we should be the ones carrying our astronauts up. Not somebody else. We shouldn't rely on other countries to do things for us. I don't think we should be relying on people for especially what we have going on Station. I've been through the modules in Houston, and I think that those guys that are up there need to be applauded every day.

The concepts for replacement vehicles for Shuttle—they should be designing something new, but I still say unless you get the old graybeards in here, talk about the things we've been doing, lessons learned and how you can go apply the technology of the Shuttle and the way we built them, the way we assembled them, the way we test them and all the things that the Cape does. Everybody's off doing their own thing right now, and you're going to go through this huge evolution of testing to prove something that if you got a few old other folks involved that can help shorten that build cycle or that test cycle or that learning curve. I don't see it, I don't see it. It's probably not my problem, but we're all paying for it.

I think Atlantis will fly one more time. I think that's a given, it's a good thing. And I think that between now and then there'll be more flights added too.

I think you asked me will the orbiters be safed or decontaminated? No, we don't do any in California. We don't do any safing or decontamination of vehicles. All that's done at the Cape, which when we bring orbiters to Palmdale for any type of mods or inspections, they would always safe the vehicles in Florida. Remove the hypers, remove the APUs and ammonia boiler tanks and all those things, and safe the vehicle prior to coming to Palmdale.

I really don't have a clue where the orbiter is going to go. Everybody is campaigning for them. I think that once the orbiters are done flying, probably 2013, maybe 2014, you'll see the orbiters going. I think it's given that one is going in the Smithsonian [Institution National Air and Space Museum, Washington, DC]. Edwards Air Force Base has a museum. They're on a huge campaign to put Enterprise in that museum because of the things that Edwards did for the ALT program, which makes a lot of sense. All the vehicles out there that are in the museum today are all flight test aircraft. I don't know if they're going to win that, but I think for the program it would be the right thing to do.

WRIGHT: You'd like to see Enterprise come home?

KAHL: Not necessarily come home, I just think it's the right place for it because of Edwards's involvement during ALT, both the Air Force and NASA, and the things that took place out there. It's just if you look at history, that's where it started. So why not preserve it there? Which one will go in the Smithsonian?

WRIGHT: I think Discovery is the one.

KAHL: I've heard rumors, Discovery. That's the right place for it. As far as the other two, if I was a Floridian I'd say, "I want one in Florida," if I was in Houston I'd say, "I want one in Houston," if I was in California I'd want it in California. I think they ought to keep them in the OPFs [Orbiter Processing Facilities] and keep them flying myself. I would love to be retiring, watching the Shuttle go out. That'd be the coolest thing.

WRIGHT: That'd be nice for you. Well, thank you for today.

KAHL: You're so welcome.

[End of interview]