SOUTHWEST TEXAS STATE UNIVERSITY/JOHNSON SPACE CENTER EDITED ORAL HISTORY TRANSCRIPT

CHARLES THOMAS HYLE
INTERVIEWED BY KAREN L. FAUL
LAGO VISTA, TEXAS - 7 JUNE 1999

FAUL: I have to introduce myself as Karen Faul interviewing Charles Hyle.

HYLE: I go by Tom.

FAUL: Tom, Ok. [We are] at your home [in Lago Vista, Texas] on June 7th 1999. The interview is being conducted under a [cooperative agreement] between Southwest Texas State University and NASA [Johnson Space Center, Houston, Texas]. You will receive a copy of the transcript from NASA, not from me or the University. Do you understand that this interview is being conducted for SWT and NASA archives for research purposes?

HYLE: Yes.

FAUL: I guess the best place to start is biographical background; childhood, where you grew up. Beginning there.

HYLE: I was born in Anniston, Alabama, in 1938. I grew up in Birmingham, Alabama, and I graduated from Auburn University in 1961 with a Bachelors degree in aeronautical engineering. I went to work for the Navy Department in a wind tunnel, up around the

Washington, D.C. area initially, and worked for a year and a half there before I took a job with NASA. NASA was just starting in their Houston operation, having moved there from Langley [Research Center, Hampton, Virginia]. This was in 1962, October ’62.

I guess that’s pretty much it, how I got to NASA. Is that about what you’re looking for?

FAUL: Did you see an ad in the newspaper or did you just talk to people?

HYLE: When I graduated, people that I knew went different places and I wanted to get some hands on experience in the wind tunnel area because that’s what aerodynamics is about. Aeronautical engineering at that time was basically airplane design, strength and structure, power plants and things like that. I had always aspired to be a pilot, but was unable to do that. I wanted to go to the Air Force Academy, but I couldn’t. I had a medical problem which prevented me from getting in the Air Force Academy. So, getting an engineering degree was the next best thing and the job I selected initially was a hands on kind of thing to really find out what went on in wind tunnel activity and wind tunnel work. I worked at the transonic wind tunnel where the Navy tested bombs and missiles, and some things that are even used today were being tested in the transonic wind tunnel.

The other people that I graduated with went various places. One of my good friends-Jim Rutland went to work for NASA at Langley. After a year and a half at the wind tunnel I began to believe that it was a little staid. The environment was a government facility, but the NASA program was just beginning and things were exciting, so I contacted my friend who was at Langley. He was in the process of moving to Houston. He was the enabler that allowed me to get a job with NASA. They were hiring young people and that's how I got to NASA in Houston.

FAUL: What was your first position and your responsibilities there?

HYLE: Well, initially they were still conducting the Mercury Program and I was a part of the Flight Operations Directorate. The operations guys were responsible for the launch and conduct of the flights, as they actually took place. They had support wings, one of which was the Mission Planning Division, which I joined. Our function was to plan flights. Basically we ran trajectory simulations. We used a big main frame computer, [IBM] 7094. With computer simulations, which were mock space flights, we planned how the flight would look and what time various events would occur and what the pilot should or couldn't be doing within the time frames that the trajectories and flight mechanics dictated. I was in Charlie Allens section and my particular function was in the abort area where emergency planning had to take place. If something happened during the mission there were emergency procedures, and things were already prepared so that the pilot could escape if the vehicle got in trouble, during launch primarily. Abort is something that's needed, for the most part, during the boost phase because that's when the most dangerous things are going on.

I worked in the trajectory simulations and planning area initially. After Mercury, I worked on the Gemini Program, which was a two man program, basically to develop rendezvous techniques. There were ejection seats in the Gemini capsule and this was different from Mercury which had a tower, an escape rocket dedicated to carrying the capsule off the rocket if something happened. One of the first things I was doing in the Gemini

Program for Carl [R.] Huss—my Branch chief and the original Retrofire Officer—was coming up with a little simulation that would predict the path and the forces on the two men, if they were ejected during boost. Another thing that our division did was supply real time data of predicted abort landing locations. Basically it was curve fit information because you can't run simulations fast enough in real time to make the information useful.

These things were stored as curve fit routines, which are very rapid and give basic information about where the pilot's likely to land at any given instant if he should eject. There were different procedures for escaping the rocket if something went wrong during the boost phase. Depending on which stage of the launch vehicle they were on, we utilized a different escape method because we were limited by propulsion capabilities designed into the vehicle and also by what the actual failure was. Primarily I was working trajectory simulations and in the emergency or abort planning part of it. Later, I did some flight plans for the Gemini mission. Shall I keep talking about what I did in the initial phase?

FAUL: Yes, that's fascinating.

HYLE: As the Gemini Program went on—Neil [A.] Armstrong was one of the pilots who docked the Gemini with an upper stage Agena [target vehicle]. An Agena was launched on an earlier flight, and as I said the Gemini Program was to develop rendezvous procedures. The manned vehicle caught up and rendezvoused with the Agena vehicle. It had an adapter that allowed them to dock. Well, it got out of control and he utilized his flight skills to escape from that.

Planning Gemini flights was an aspect that I was involved in for awhile. After the Gemini Program was proven, the group that I was in became assigned to the Apollo Program, which was on-going at this time. The whole thrust of the NASA program, as you may recall from the [President John F.] Kennedy speech was to put a man on the Moon before the end of the decade, which would have been 1970. I joined NASA in ’62 and then in ’64 or ’65 was the time frame that I was working Gemini.

I only worked one Mercury launch, that was [M.] Scott Carpenter’s last flight, MA9. In addition to preflight planning, the group I was in also supported the Flight Dynamics and Retrofire Officers in the [Mission] Control Center in a backup function during the boost phase, and during the flight itself to predict what was known as block data or retrofire times. These were simply times which the pilot would use to fire his retrorockets if he had a problem and he was out of ground communication.

Typical of the kind of things that were developed for these emergency returns, we’d find an attitude which you could line up the Earth’s horizon, for instance, with a mark on the glass window and if you were aligned properly and out of contact with the ground you could fire the retrorockets at one of these block data times and at that attitude the vehicle would land near a recovery ship. Everything was in the water then; Mercury and all landed in water and ships picked them up. That was, again, back to Mercury, so supporting the flights and pre-flights, trajectory work. Generating displays for the flight control people to use, to call for an abort if something was going wrong was another part of what went on in my career there, during that time frame.

Then back to the Gemini stuff, after the flight planning aspect and what got to be routine production of abort plans for each flight. There were ten Gemini flights, but there was a routine production of what we called abort plans, and for these abort plans we produced data that showed what the pilot would experience if he had to abort a flight for different failures during the ascent and as a function of the flight time, because things would be different depending on how fast and how high the launch rocket was when this emergency occurred.

After that, routine abort planning report production operation went on. Fortunately we never had to utilize these plans or these abort capabilities which we defined. But, we were prepared anyway. That was the nature of what I did along with Mack Henderson and several other guys, a lot of other guys in fact. The results of a lot of our work were stored in the real time computers which the flight controllers used to monitor things in real time, to call for an abort if they could see something from the ground that the flight crew was unsure of.

Ground displays always depend, of course, on being able to have tracking coverage. You have to be able to see from the ground to the vehicle and sometimes the vehicle is out of the line of sight of a ground tracking station. At any rate, basically emergency procedures and that sort of thing and trajectory simulations and some real time support while the flight was actually going on was what I was involved with, flight mechanics. My plate was pretty full during this time with my family plus pursuit of a Masters degree in Mechanical Engineering from the University of Houston.

After we were through worrying the Gemini launches, my group was moved in with the Apollo folks who had been doing general planning and studies for the most part on aborts and what to do if things went wrong at any time during the lunar mission that Apollo was all about. That entailed a whole new world because the initial Apollo flights were two stage rockets, the S 1B [Saturn 1B], and then later the Saturn V, which was this monstrous multistaged rocket. Actually it was a three-staged rocket and capsule sitting on top of the Service Module which had propellant and propulsive capabilities of its own and then underneath that, an adapter with a Lunar Module [LM] which had propellant and propulsive capabilities.

So, my group joined with the folks who were studying what to do if an emergency should occur during an Apollo mission. Of course this was a huge task because basically the boost phase, where the emergencies could occur during first stage, second stage, or third stage, and each of these stages had a different number of engines, and there was the separation of the upper stages from the failing stage, that was the initial activity. There was a group of folks down the hall who just worried about vehicle separation events because with all the aerodynamics, up to 60,000 feet it's very difficult to pull off much of anything if the vehicle is not under complete control.

This is kind of a rambling discussion you could say because it was just a complex thing and it's hard to walk through sequentially with all the possible failures and which failures could occur during different stages. In different stages of flight you could either be in atmosphere or in a partial atmosphere or later on, out of Earth's orbit where there was no atmosphere. Abort/recovery possibilities were completely different during each of these flight phases. Each time you analyzed what could be done you had to consider what was available to you as a pilot in order to rescue yourself and the other members of the crew. Basically, what we simulated was the use of propulsive capability, which they still had at their disposal.

In the Apollo program, there was a Service Module which was used to perform mid-course corrections en route to the Moon and after the upper stage of the Saturn set us on a path to the Moon. The Service Module is also used to bring the combination LM and Service Module and Command Module into the lunar orbit. In other words it did a retrograde maneuver when it got to the Moon and put us in a circular orbit around the Moon. So we studied things like what if the third stage stopped half way through or three-quarters of the way through the Translunar injection burn. You would be on this trajectory which would not go to the Moon as you had hoped and you'd be in space. Theoretically everything would be okay with the upper module where the crew was, but they had to somehow get back to Earth and they may not have communications all the time. We again used procedures that we had done in the past where we could look for the shadow of the Earth and the horizon and with scribe marks on the windshield, little incremental degree marks, give the crew an attitude to utilize to line up the vehicle so that when they fired the rockets at a certain time, or certain Delta V as we called it, they would very likely come back to Earth safely.

One of our biggest concerns aside from a reentry, at the higher speeds like when you go to the Moon, the heating on the return was excessive and the aerodynamics, when you approach the Earth at high speed, could either cause the vehicle to skip like a stone skipping on water, and skip out, or if you came in too deep then they pulled too many G's (high acceleration) for the flight crew. There were fairly limited conditions in which you could return to Earth, and using these crude methods was pretty awkward, but if you didn't have another approach, that was about the best that you could do. We did the best we could with what we had for emergencies that the vehicle itself was intact or some piece of the vehicle was intact.

We also studied other failure modes, as they were called, that resulted from the S 4B or the third stage losing control, or it's inertial platform drifting or not doing exactly the right thing, so that there were errors in the burn when the vehicle cut off and the trajectory still would not allow them to get to the Moon properly. There was a range of trajectories where they could come back directly to the Earth, then a range of trajectories that would allow them or suggest that our best approach was do nothing and coast to the Moon. Use the Moon's gravity to sling us around and return to Earth.

We were always looking for the minimum Delta V solution, it was called. That was the minimum propellant expenditure, since we had a limited amount in the remaining vehicles, being primarily the Service Module and perhaps the Lunar Module which, of course, was not going to be used to land if you're in the abort mode.

The only other thing I can think of in the abort planning, was there were aborts from the lunar sphere, if the Service Module was docked with the LM and they were on their way to the Moon and they started doing the breaking maneuver into the lunar orbit, if that burn should not take place properly they could either impact the Moon or they could get into very peculiar trajectories that meandered around the Moon and eventually would crash. Or they could do any number of things depending on how that burn took place. It was all pretty sensitive stuff and we looked at all sorts of failures.

You may or may not know that there were redundant computers on board so if that one failed or one was not doing the right thing then another one could take over. And knowing when one was not telling you the right thing was not easy either, and which one to switch to. Anyway, redundancy was a big part of NASA and that was part of what I learned, planning and practicing and having a second and third way out of a situation is always a good idea. I believe that is good for life in general. You don't go on a trip without checking your tires, and even if you check them you have a spare.

FAUL: Yes.

HYLE: That's kind of what the Apollo experience for me was about. All this took place while I was in the Mission Planning Division. That was the first ten years of my career. I'll just stop right there and ask you if you want to delve into any of those kinds of topics. Or go to the [Space] Shuttle or what?

FAUL: I just wanted to, the name of the wind tunnel that you worked at? You had mentioned the name, but I didn't catch it.

HYLE: The facility was a Navy facility called the David Taylor Model Basin [Bethesda, Maryland]. It was a test facility for the Navy Department and they had big water tanks and wave tanks and they took model ships and put them on stings, as we called them, or a device which would drag the model through the water. They could determine the drag of that model and its tendencies to roll or vary its attitude. They could simulate waves, wave heights like in the ocean, and they got the reactive responses of the models in near real-time conditions.

Of course, this is a very valuable tool and that's largely what aerodynamicists do, they make predictions with pencil and paper. No one had personal computers in those days, but there were large computers. There's never been a closed form solution, which means you can't get an absolute answer, so the best you can do is approximate with equations of motions what the circumstances are, and then the best equations you can have will usually give you a clue, or a good idea of what is likely to happen in the real event with the actual ship or the big airplane or the big missile. Aerodynamic testing—well I was talking about ships and the testing of ships, but they also had wind tunnels, subsonic, transonic, and supersonic wind tunnel at the David Taylor Model Basin.

My job was in the transonic tunnel. When you go from subsonic speeds to supersonic speeds there's a major hiccup at Mach 1. That flight regime was a big problem for studying aborts later on in my career at NASA. Design conditions occur frequently for a piece of structure as a result of having to contend with this maximum dynamic pressure, which occurs when the vehicle goes from subsonic flight regime into the supersonic flight regime. There's this massive shock wave that attaches to the vehicle and walks down the vehicle and when finally you are going fast enough that the vehicle becomes supersonic then the aerodynamics smooth out considerably. But transonic is very unpredictable and there's all kinds of buffeting and shaking and rattling and if you're not designed for it then it can tear the vehicle up. I worked in transonic wind tunnel at David Taylor so that's the answer I guess.

FAUL: In mission planning there was a huge computer that held all of the trajectories. It was I believe you said 7094. Is that correct?

HYLE: Yes. IBM was the primary computer support wing for NASA in those days. IBM was always Big Blue because they were known to have the best or felt to be the best. I'm not making a plug for IBM, but it was true everybody believed IBM provided you with the best when it came to computers and they had mainframes that were huge rooms of computers. They were not nearly as sophisticated as the things we've got on our desktops. I've got a little laptop now.

Those 7094's were used two ways. We had off line 7094's with which we did our planning work on a daily basis. And in the Control Center, they had a dedicated set which provided what was referred to as real-time information, real-time data and real-time capabilities. And the real-time computers were used to display information about the flight to the flight controllers that you see on television.

The flight controllers were looking at pre-established displays of various flight parameters coming down to them from the vehicle. For instance, there's tracking information about the vehicle's velocity, flight path and altitude being sent to the ground. This particular piece of information would be sent to a particular person on the ground called the flight dynamics officer. The flight dynamics officer generally kept up with the flight mechanics aspects. Other typical telemetered data might be like fuel cell pressure and temperatures where the onboard vehicle electricity or power is generated.

That kind of information was also telemetered down to the ground and a separate flight controller would look at that information and all together they knew pretty much what was going on with the vehicle and they could help the flight crew keep up with what was happening. It was like another whole group of heads looking at the situation to advise you if you were beginning to have a problem that the flight crew might not notice. They all simulated failures in practice and different things going wrong. As a team, we had a group of guys that would produce insidious failures during practice simulations driven by the ground computers and then the result would show up as though a real failure were occurring.

In these practice simulations, the crew would be in a flight simulator somewhere and they would get indications and the ground controllers would get indications and between them they would determine whether or not they should call an abort or terminate the mission and try to get back safely, or whether it was something they could live with and to press on. So that's what the 7094's did. And later on 360's were substituted, IBM 360 mainframes. I'm not sure what they're using now.

FAUL: With the practice simulations, did you actually have a hand in the practice to plot in all the evil mistakes.

HYLE: No. There were separate people who developed—see all of that was like failure generation models with software. We in conjunction with the people who built the vehicle and the people who were going to use this information during flight would develop displays. Like some guy says, "I can't possibly look at the attitude all the time, I can't possibly be watching this, so I need a different parameter, something that's not moving so much." So we would find something would be amenable to evaluating, and of the possibilities that we had and that were to be telemetered and then presented in the display, and then real-time data would get plotted onto that display and we would put limiting circumstances on the display that we built. These limits could be put onto the real-time displays before launch. The real-time data coming down was brought in through telemetry and injected into the computers onto those particular displays for that individual, and they would see, in real time, where they were compared to conditions which allowed them adequate escape time if they got to a limiting condition.

The people who generated the faults were separate kinds of guys and they would manipulate software that would produce traces on controller displays like the telemetered information. We had nothing to do with telemetry of the information coming down from the vehicle. These guys would input information as though it were the telemetry from the spacecraft. We were also investigating flight conditions independent of an initial failure. We just needed to know aborted flight conditions, when we defined a limit (i.e., structural breakup) we could then plot them on that display. If you go past this line you should abort, you'll have five seconds to get away before this thing explodes or you lose control.

FAUL: I guess those were the only questions that I had. So, that was your first ten years?

HYLE: Yes.

FAUL: It seems like a heavy load.

HYLE: Well, it was interesting, after we did the first two or three flights of each vehicle it became more routine and it was like what we were doing became a production. As I said earlier we produced an abort plan and distributed it so that everybody would know what to expect from this flight. It was built off a trajectory which was designed to get a certain payload to a certain orbit. That given trajectory defined everything pretty much from which we could start practicing our emergency conditions off of. Then from the abort plan came information for the real-time displays, and information and limits that went into the real-time computers to show the flight controllers when they should call for an abort, and information that would go to the range safety people to position ships.

They couldn't, of course, blanket the Earth with ships. There were specific recovery areas which tended to minimize the time that it would take to get a ship to a vehicle had it come in. So, they were spaced around the world. It was a load and particularly in the Apollo time frame when we got the go for the first mission to the Moon in December'68. Of course, everybody was really excited because that was a year earlier then we had expected, but we had to do a lot of fast shuffling and there was a lot of interchange.

We had panel meetings which required travel to and from the [NASA] Marshall [Space Flight] Center [Huntsville, Alabama] because they were responsible for the launch vehicle, with the Rockwell [International] people who were building the Service Module, so there's a lot of communication all over the country and around the world taking place. After four or five lunar trips it became kind of a production thing for me and my group.

I became Head of the Contingency Analysis Section about that time and other guys reported to me and I coordinated their activities so that we were all playing off the same sheet of music. We had someone working the next flight or two ahead and those sorts of things. Anyway, it was an interesting time. And then, like everything, there's good and bad times. After that, the Apollo Program, people started to question, "Why are you guys going to the Moon? What are you doing with that?" They almost shut the agency down in the early 70's. That was a downer and, of course, the fire of 205 [Apollo 1] before the first manned launch. But, anyway that was my first, in the missions planning, the first ten years and so that's a good break point.

FAUL: With Apollo 13, did you have to stay there twenty-four hours to help figure that out?

HYLE: No. That always was a little twist for me. The interesting part of that to me is that guys in my group participated in the development of the procedures that allowed that recovery to happen in a smooth way. I don't mean the part where they were out of oxygen and had to rig up tubes in the spacecraft. I mean the plan to use the LM as a return device. We had studied the range of trajectories you could be on, and depending on where you were when you made the commitment to return, how much Delta V and propellant it took to get you home and if in fact you had enough.

A lot of that work had taken place so that the ground controllers were comfortable with committing to using that process. The guys in my group developed those ideas and there were contractors supporting us. The TRW [Incorporated] people were subcontractors to our divisions and they helped us do all kinds of things, including develop ideas like that. And the guys that worked for the government, such as myself, also ran trajectory simulations that some of the TRW people had created and ways to bring back the flight crew.

I always felt sort of glossed over naturally since we weren't part of the celebration, but, there were a lot of guys who spent a lot of hours and did a lot of work in the background that no one ever knew took place or didn't know particulars. All the emphasis was on the guys on the line at that instant. You know, "What are we doing next? What are we doing in the next fifteen minutes? What do we do in the next ten hours?" Not that there weren't a lot of creative and a lot of ingenuity taking place on that front, because there definitely was. But, inside of me I always felt pretty good about the fact that our group had done its job so that it was pretty transparent when it was really needed.

FAUL: When [the crew] was brought back?

HYLE: Yes. That that capability was there—using the LM.

FAUL: I guess that's all I had for that section.

HYLE: I guess the only other or remaining fifteen years, I was actually with NASA about twenty-three years or twenty-four. I spent a year and a half with the wind tunnel, David Taylor and then came to NASA in October '62. And then in about '74 the Shuttle was beginning to pick up. The government, the United States hadn't committed to doing the Shuttle. There was a lot of effort to shut the agency down because there was no clear need for saying we should keep going to the Moon. There was a lot of controversy with should we or should we not have a NASA.

The logical thing for the people who said that we needed NASA, of course, was a manned space flight contingent, and to do a manned program. The next logical thing was something that you could reuse because Apollo was so expensive, so that's how the Shuttle got going. It had been actually going on in the background for a long time, by a lot of people looking at winged vehicles. Anyway, our group was split. I had about ten guys in my group then, at the end of Apollo. Six of us were transferred over to the engineering division in '74 and we began to help the engineering guys with the design of the Shuttle.

The Shuttle concept had been put out for bids to contractors, "Hey, here's what the Shuttle would look like." It ended up being a contest between four large aerospace companies and, of course, North American won the orbiter. As a part of my career in that aspect I then was in the engineering division, where I also became what was called the Abort Subsystem manager. Again, we were doing analyses which enabled us to figure out how to best use the Shuttle if an emergency happened during its flight, and with the solid rocket boosters, that was a lot more dicey.

Initially, the Shuttle was scheduled to have all kinds of gadgets that would detect, hopefully, at least the idea to detect things like ultimately that caused the blow up of STS [51-L, Space Shuttle *Challenger*]. For various reasons that stuff didn't get put on and I'm not suggesting that had we done it, that would have been avoided, but God only knows. But, there were all kinds of intentions early on that were ruled out because of cost and weight, including devices that would sense what was known as the burn through problems, where that thing burned through the stages of the solid rocket boosters. They are composed of cylinders stacked like these cans [demonstrating] stacked on top and at the joint there is in fact a joint that leaked. That's what happened.

Automatic aborts and software to support that was initially a part of it and that was a big thing that got tossed out because not many pilots wanted to ride a vehicle where in one instant they're cruising along and the next instant something had shut the flight down or sent them on some other path. They, of course, always want to be in control of that. But, a lot things like that burn through that they don't have knowledge of and who's to say, I don't know.

One of the things we were always trying to figure out was how to know if something was true or not, because frequently sensors give out bad information. Sensors could tell you that something was wrong when there really wasn't, so that's really when we got into the Shuttle program, when this redundancy logic became big time stuff. We had four computers and one was used to break a tie if any one of the three were giving out spurious or strange signals. We could pull each one out and stick the fourth one in and see if the deviant was in fact telling the truth and if the others were not. It was just very complicated. At any rate, a lot of that stuff was taken out because of cost and weight, as I said a lot of software stuff from the onboard computer.

The Shuttle was unique in that there were no ejection seats, there was no escape tower and there was no launch abort rockets, so once they lit that thing off the ground the crew was locked onto it for around two minutes or so, until the SRBs, the Solid Rocket [Boosters], got off because the aerodynamics pretty much precluded the Shuttle from getting away safely because of all the high aerodynamics and the wings were fairly sensitive. A big glider is not able to take a lot of twisting and buffeting such as the rough aerodynamics that occur when that tandem vehicle with the solids and that tank and the aircraft strapped on the back.

It was a real design challenge, but I think that was probably the most fun in my career. That era when I was in the engineering group and we had a small group and there was just loads of work and we all played well together, because each of the different groups in the division had a function that was related to the other pretty strongly. We also directly supported Shuttle Program Management through Bass Redd, our Division Space Shuttle Manager. There was an aerodynamics branch and the Shuttle was all about aerodynamics and also some flight performance and separation people. At any rate, that was an exciting time, in the design phase of the Shuttle and developing procedures to escape. Defining the conditions in which you could in fact safely escape was a challenge.

The Shuttle was designed to lose a single engine, that is, it had three liquid fuel engines and it could sustain a single engine loss and still survive. The first half of the flight after the solids went, the return mode was called Return to Launch Site. No one liked that because it effectively slowed the vehicle from going down range, and the guy has to do a 180 and head back toward the launch site, slow himself down and then make a glide back to [NASA] Kennedy [Space Flight Center, Florida] where he had been launched. The resulting entry was a lot steeper than they entered from when they returned to Earth, and they pulled a lot of G's [gravity]. Acceleration forces are very high and it tended to over load the wings.

Because the Shuttle was designed to fly like an airliner, you didn't sense any more acceleration. If you've ever been on an airliner when you take off you might hit a couple of G's sometimes when the wind, the air drops you real quick. You are just left in mid air and sometimes when he pulls up you're driven into your seat. Those are G forces and they can get very high on Shuttle abort trajectories and nobody liked that Return to Launch Site.

Later, they eliminated it, but a lot of time was spent studying that and flight procedures and trajectories and simulations and displays, all the things we'd traditionally done got worked on prior to the subsequent procedure, which the vehicle essentially would go down range and they eventually developed a landing site in Spain. Where, the things that occurred earlier, you could still, with two engines, get over to this Spanish site. The second half of the launch phase, if that engine went out, we did what was called an abort to orbit. Where you simply used the remaining two engines to get on orbit and then you had more time to decide how to get back.

That all took a special meaning for me when one day I was returning from the Rockwell plant where I'd go periodically. I was on a DC-9, which is a two-engine airplane, and it lost an engine during the take off, and scared me out of my wits [laughter] and of course made a loud noise and [the pilot] immediately returned back to the landing site. Just like our return to Earth, but since I was working in an office and did not have real world experience, everything I did was associated with computers. That was quite an interesting event. But anyway, I liked working in the engineering directorate and the guys there were real go-getters.

I was there for several years, three or four I guess. After the Shuttle was pretty much designed, we were effectively on loan from the Operations Directorate to the Engineering Directorate and the Bosses said that it was, "time for you guys to go back home because the vehicle's pretty much designed." He gave us a chance to either return to where we were or to try something else. I chose to do something else. I then went to the Shuttle Program office and worked for some real good guys and broadened my perspective a whole lot, because then we looked across the whole Shuttle Program and not just the design or the engineering aspects.

The function of the office that I was attached to was an integration function. We integrated what was going on at Kennedy, that is the hardware being built at Kennedy, to stack the vehicle together and the turnaround time. My task in the program office was part of the systems engineering office. There was an individual assigned to monitor or mother, they called the term, the liaison function between the world that that function involved, like there was a rocket guy and he interfaced with the rocket division at Rockwell and the rocket divisions at Marshall, where they were developing the rockets. We had this one guy that was a specialist in that area. I was the person for aerodynamics and flight performance, which is basically the fuel, how much fuel can we carry, what are the ways we can come up with that allows us to deliver more payload to orbit.

I was involved basically with flight performance and aerodynamics and flight control during the ascent phase of the Shuttle flight. That's what our system engineering office focused on. We had to make sure that all the pieces that played together during ascent actually did what they were intended to do. Did they make the requirements so that the other guys who had to use that capability could count on it actually being there? So there was a lot of communications. A lot of meetings where the guys from different parts of the country were together in the same room and we all worked on action items which assured that things were done to meet the requirements of the design. A lot of people around the world would look at the design and requirements and say, "Hey, this thing's got a switch that when you put it in the up condition this will happen," and we had to know that that switch was actually in the cockpit, for instance, and if you put it up, it actually did what it was supposed to do. If it had a back up path, you could use this if it didn't do it initially and can you read it from the ground when they're on orbit.

To see that all this happened there were a lot of meetings. The program office was headed by Bob [Robert F.] Thompson, as the program manager and Owen [G.] Morris was the manager for Shuttle integration. His deputy was my boss, the manager for system engineering. My immediate boss ran what was called the Ascent Flight System Integration Group and we focused again on the pieces that made up the boost portion. The guys from the solid rocket world, the guys from the main engine world, the guys from the external tank world, the guys from the orbiter world and the guys from the trajectory/aerodynamics/flight control world, we all had to know what each one was doing to a certain degree.

These components of these vehicles were held together with struts or mechanical links that were separated with explosive devices at certain times in the flight so that the SRB's would cut loose, and all this was done with pyrotechnics. When they spent themselves two minutes into the flight they burned themselves out, the Shuttle was going so fast. The throttles on the main engine were ramped up and then the power all came from the liquid fuel in the external tank. Those struts were critical, they were designed during the ascent and so we had to know whether they could sustain loads that occurred during the ascent, like at high dynamic pressure when you get this big shock wave. And if the trajectory was not behaving as you'd expected, could the wings stay on, would the struts brake and the orbiter flop back on the tank? So we studied structural aspects of the ascent flight and the aerodynamics that went with that. Those are the two main focuses in the AFSIG, the Ascent Flight System Integration Group. We developed rules and plans that allowed us to fly the first few trajectories without knowing if a shuttle-like vehicle could actually fly.

So there was all this element of risk because you could test a single engine on the ground and you shake a vehicle and vibrate it and you could load the orbiter and tell what the static responses were to loads that hung on the wings, but you didn't know exactly what would actually happen. We put a limited amount of instrumentation in the vehicles and as we flew them, starting with STS-1, we got some information back, like from strain gauges on the wings half way out on a spar.

We knew what the load was and we knew within a certain range what its aerodynamics were. We had predicted aerodynamics, but we didn't know what the real aerodynamics were. The only information we had was how the vehicle was oriented in the sky, how fast it was going and what the strain gauge said. So, we started backing out information about aerodynamics and how fast it was going and all sorts of things. We eventually ended up with equations called load indicators, which we could stick into a trajectory simulation and use these indicators to tell us how safe it was to fly a certain trajectory. If we flew this trajectory and the load indicators got to the limiting conditions then we'd know, "Hey, we better not get this far away from the plan".

All that became invaluable for another major effort that I was involved with which was called the LSEAT or Launch System Evaluation Advisory Team. We were there for instance at two in the morning before Shuttle launch at eight. And we used the winds of the day. There were a group of guys at Marshall who had been launching balloons at Kennedy for ten or fifteen years and they would monitor balloon ascent with radar and get its altitude and the direction of the wind and then the speed of the wind. They recorded all this data, they had tons of this information, so they generated what was called 3 Sigma envelopes, and it says if you were at 30,000 feet and on this day in February chances are that you would have a wind speed no faster than this amount, and its dominant direction would be from the Northwest, things to that effect.

So, we knew how fast the wind was likely to be on a given day, which direction it's likely to be coming from, within a certain probability. We always liked to commit a Shuttle launch to its maximum launch probability, so we would explore all these wind profiles with a simulation and then during the pre-launch phase, the eight or twelve hours before launch. Well, let me add that we could define envelopes inside of which if the Shuttle remained, for instance during the month of February, he would not experience wind loads any larger than this. And the wind loads produced some additional taxing of the wings, over and above the taxing that was the result of the speed and aerodynamics. The wind just added some more load. The question became, "Was that wind load addition that we were not really knowledgeable about likely to be enough to break a wing or bend something or not?" And if it was, we'd have to back off and that would give us a certain probability of launch.

And I don't know if you're following any of this, but what it really means is that we could predict a launch probability to within a certain degree, like five percent we would be within a five percent probability of a successful launch opportunity in February if we flew this kind of a trajectory, because we could analyze and use the load indicators to tell that nothing would break. And then during the pre-flight time frame, they would take real winds from Kennedy starting twenty-four hours out and see how it goes. Where is this wind with respect to the 3 Sigma window envelope? Is it in the middle or is it out near the edge or is it getting dicey? Are we likely to see these higher loads that are a result of a severe wind like they have sometimes? Or are we likely to see benign winds like they have most of the time?

So, we could tell how that wind was with respect to all the winds that we looked at for twenty years. We run the wind through the trajectory and predict. We could take a wind in as late as three hours and come back with the load results an hour before launch and then my boss would give the launch director a go/no go for launching the vehicle from the wind load standpoint.

That was an exciting thing. The only bad part about that was being there at two a.m. But two or three guys had some heart consequences as a result of the stress associated with those kinds of things. After several of those Shuttle flights and up to the time when STS [51-L] blew, that’s basically what we were doing. We were designing and tweaking the ascent trajectory to make sure the wind loads were acceptable to the orbiter and to the various components.

After that accident things went into a mode which was a little more than I wanted to be in. It was just a drudgery time, where you went back through all the paper to make sure that the requirements were being met and that we actually needed those kinds of requirements. It was just not a good time and there had been a lot of change in personnel and management. Many of the guys I had formerly worked for like Tom [J. Thomas] Milton had all retired or taken other jobs. I had an opportunity to take an early retirement, so I did and went into school teaching. That's that. That's my NASA career in an hour.

FAUL: Where are you teaching and what are you teaching?

HYLE: I became a high school math teacher after I left NASA. I left NASA in early 1987 and started teaching in a high school where I taught math. I went to the University of Houston at Clear Lake and got my certification and then began teaching at Clearbrook High School which was a couple of miles from my home. It was a brand new school in the Clear Creek [Independent School] District.

That was an interesting routine. Nothing at all like NASA, but that was part of the reason that I went into it. I like kids and I had two daughters who I had seen struggle with math and I thought I could so something that would alleviate the problems. I began to hope to help girls overcome some of the obstacles which I thought they were encountering. However my experience was for the most part the girls were better at math than the boys that I had, and they're better students as well. But, I had up and down times teaching school.

There's a lot of problems with young people in that era. That was in '87 through '95, I was teaching high school math. And I taught one year at night at the Houston Community College. My last year teaching at Clearbrook was 1995 and I had great students and I really enjoyed them, but we had been wanting to sell our home and my son had gone to the University of Texas [Austin, Texas] and he kept telling us that we ought to come look at Austin for retirement.

We had in fact taken a few trips around the country looking at different sites, Florida, North Carolina and even San Diego [California]. Then we looked in Austin and decided that this was a pretty good area. We fortunately found this place. We sold our house, and things were changing at the school, so I took a retirement there and after we arrived up here, in the Lago Vista area, I basically readapted for the first year. Then I took a job part time with the local high school, tutoring math. I explored my interest in computers and now I do part time computer work and Internet and things like that. So, I'm enjoying things and feel like I had two good careers and now I'm in my third good career.

FAUL: I was about to say, you never really retired.

HYLE: I really enjoy working on computers.

FAUL: Great.

HYLE: I'm taking some courses at the junior college, networking and that kind of thing, local area networks, Novell and NT. But that's pretty much my career so far.

FAUL: One last question, real quick.

HYLE: Sure.

FAUL: If you look back on your career is there just one thing that really stands out if you're just chit chatting/talking about what you did? Really bad or really good?

HYLE: It's hard to do that because there were significant events in my lifetime regarding the whole world perspective. Of course, the first one was the lunar landing and the early flights prior to that when [Frank] Borman, [James A.] Lovell and Bill [William A.] Anders went around the Moon, that was very exciting and then Neil Armstrong stepping onto the Moon. We were all in the Control Center that instant when they landed and later on when he stepped on the Moon it was in the middle of the night so I was at home. We were always in the support function and so practically everyone from the support groups were in the Control Center. And when these guys landed, it just kind of took our breath.

But the other exciting time, I can't say that the first was a whole lot better but when I saw the Shuttle fly, STS-1 and John [W.] Young and Bob [Robert L.] Crippen flew that first Shuttle. That was just a tremendous thrill. Of course, we were watching on TV. Again we were in the support functions in the support rooms, but to see that complicated beast and those different pieces that had been worked on by thousands of people all over the place, coordinated and integrated basically through functions like I was a part of in the program office. That was just a terrific experience.

I marvel at a lot of things and I think that there are a lot of other things that go on in this world that are probably in the same domain as those. I mean launching these oil rigs that float out into the bay and they turn these things on their side. There are just so many remarkable things, the building of bridges and how people did this historically. Looking back who built the Brooklyn Bridge and constructed the Empire State Building. Mankind has done some remarkable feats and I marvel at all of those. I'm just fascinated by how mankind pulled himself up by his bootstraps. But I felt like I was a part of a couple at least and probably more than that, but those two things stand out in my mind.

FAUL: Well thank you.

HYLE: You're quite welcome.

[End of Interview]