

Memories of Chuck Ordahl:
A witness and contributor to the evolution of
missiles, rockets and space vehicles.

Table of Contents

<i>Chapter 1: The Early Life in North Dakota 1934 – 1952.....</i>	<i>7</i>
<i>Chapter 2: The College Years and Moving to California, 1952 -1956</i>	<i>16</i>
<i>Chapter 3: Starting out at Douglas Aircraft - June 1956.....</i>	<i>23</i>
<i>Chapter 4: Thor IRBM Program (Development) 1956 -1957.....</i>	<i>26</i>
<i>Chapter 5: Getting Married – 1957</i>	<i>31</i>
<i>Chapter 6: Thor IRBM Operational Deployment and Project Emily, 1958-1960.....</i>	<i>33</i>
<i>Chapter 7: Children and Our First House, 1960 – 1965.....</i>	<i>41</i>
<i>Chapter 8: Skybolt Program, 1960 – 1962</i>	<i>48</i>
<i>Chapter 9: Early Military Space Programs 1962 – 1972</i>	<i>51</i>
<i>Chapter 10: Saturn /Apollo Program and the Saturn SIV-B Simulator 1965 - 1966 and Apollo into the 1970's</i>	<i>55</i>
<i>Chapter 11: Electronics Department and Thor 520 1966 – 1969</i>	<i>56</i>
<i>Chapter 12: MOL Program Cancellation and Delta 73 Failure 1969.....</i>	<i>58</i>
<i>Chapter 13: Thor/Delta Engineering Reorganization - plus the New Life in OC 1969-1979..</i>	<i>62</i>
<i>Chapter 14: Delta Program 1960 to 1988 and PAM Program 1978-1984</i>	<i>68</i>
<i>Chapter 15: Japanese Space Program 1982-1984.....</i>	<i>74</i>
<i>Chapter 16: Purchasing the Seaview House.....</i>	<i>77</i>
<i>Chapter 17: Space Transportation Division and VP promotion 1984-1986.....</i>	<i>80</i>
<i>Chapter 18: Delta 180 Project (Code Name: Vector Sum).....</i>	<i>83</i>
<i>Chapter 19: Huntington Beach Engineering and Operations Division and Delta 178 Failure</i>	<i>86</i>
<i>Chapter 20: Delta II Program 1987 – 2018</i>	<i>92</i>
<i>Chapter 21: Space Station Program 1987-1992</i>	<i>95</i>

<i>Chapter 22: Space Station "Keep it Sold" Activities and the Washington DC years 1987-1993</i>	<i>97</i>
<i>Chapter 23: Space and Defense Systems Organization 1992-1994</i>	<i>103</i>
<i>Chapter 24: Advanced Systems and Technology Division 1994 - 1998: DC-X 1995-1996.....</i>	<i>108</i>
<i>Chapter 25: First Retirement 1998.....</i>	<i>112</i>
<i>Chapter 26: World Travel, Conferences and Vacations (not covered elsewhere) 1975 - 2015</i>	<i>114</i>
<i>Chapter 27: Delta and Sea Launch Consulting, 1998 - 2015</i>	<i>123</i>
<i>Chapter 28: Ground-Based Midcourse Defense (GMD) Program 2000 – 2019</i>	<i>126</i>
<i>Chapter 29: The Stroke - 2014</i>	<i>130</i>
<i>Chapter 30: Second retirement 2019 ——?</i>	<i>132</i>
<i>Chapter 31: Looking to the Future</i>	<i>134</i>
<i>Appendix of additional photos:</i>	<i>136</i>

Introduction

At age 85 there are two primary reasons I decided to write this memoir. First, it will be a reference for my descendants sharing with them a history of what was accomplished in my life. Second, I was fortunate to have had a long career in aerospace at the beginning of the missiles and space age and have thereby been one of the pioneers of that era. Over the years many of my colleagues have suggested I write the story of my career so that others might benefit from the experience and lessons I learned along the way. I have tried to meet both purposes. In a small way I hope this record provides some valuable insights to any and all that read it.

Acknowledgements

The accomplishments of my life and career, as well as this memoir, were enabled and supported by many people along the way. Key among them are:

Parents:

Oscar and Violet Ordahl

Teachers

Joe Birkland

Harold Bliss

Cora Lykken

Hazel Sutterlin

Mentors:

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Pete Drummond

Ken Francis

Bob Johnson

Ted Smith

Dick Ward

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Caitlin Chamberlin

Charlotte Chamberlin

Susan Eggen

Bill Harris

Eileen Ordahl

Kevin Ordahl

Sharon Stout

I dedicate this memoir to Eileen Ordahl my dearest wife and partner for 63 years.



Chapter 1: The Early Life in North Dakota 1934 – 1952

I was born in Grafton, North Dakota on October 28, 1934. My parents are Oscar and Violet Ordahl who were married in about 1932. I am of Scandinavian decent. My paternal grandparents (Ordahl) emigrated from Norway in about 1875. My maternal grandfather (Peterson) emigrated from Sweden in about 1900 while my maternal grandmother was of Swedish descent and born in Iowa.

Ole Ordahl, my grandfather homesteaded and farmed about three miles west of Grafton, North Dakota. August Peterson initially farmed near Donaldson, Minnesota and later purchased a farm very near Stephen, Minnesota. Both farms were in the Red River valley which is an area of very flat rich soil formed near the end of the ice age and is especially well suited to agriculture. The Red River forms the boundary between North Dakota and Minnesota. Grafton is about 15 miles west of the Red River while Stephen is about the same distance east of the Red River.

My father initially farmed with his brothers and sisters on the Ordahl homestead. Sometime in the 1920's he got a job at the state school for the developmentally challenged where he was initially employed as a fireman and later as an electrician. My mother worked at the same school as a nurse's aide starting about 1930 or thereabouts. They met and married and shortly thereafter they purchased a small house on the west side of Grafton not far from this state school where they worked. My sister, Susan, was born in 1939. Together we lived in this same house throughout childhood and high school. Grafton was a relatively small town of about 5000 people which would be somewhat more if the surrounding farms were included in the community.

Our small family didn't have much money, but I didn't feel particularly poor. Certainly, there were others in the community that had substantially more wealth. During the early years the economy was still barely coming out of the Great Depression. Fortunately, my parents had stable jobs. Some others were on the government Work Projects Administration (WPA), which was a government program initiated during the Great Depression of the 1930's. I recall often seeing these folks working with shovels digging ditches. I also recall camps near the edge of town where people with no work at all hung out. I know my Dad had sufficient

funds to loan some money to friends that were less well off during these tough times. They paid him back in later years with weekly deliveries of butter and eggs.

We went to the Grafton Lutheran Church. There I attended Sunday school and completed confirmation. Our family had one car. The first one I remember was a 1932 Chevrolet and after that they bought a 1940 Pontiac which they kept throughout the war. After the war they bought a 1950 Pontiac. Dad cared for them very well.

I walked to the Grafton central school no matter how bad the weather was and sometimes it was pretty severe (The temperatures could be below minus 30 degrees and it snowed often). As a kid I played all around town. The key requirement was to return home for dinner when the city siren sounded at 6 PM. I think the siren also rang at noon for lunch but I do not recall for sure.

On weekends my parents often traveled the 30 or so miles to Stephen, Minnesota to visit my maternal grandparents. Sometimes in summer they would let me stay at my grandparents for a week or so. These were always very good times. It is interesting to recall that when I was very young, we crossed the Red River by ferry boat to get to my grandparent's farm but around 1940 a bridge was built which made the trip easier.

Each summer the Ordahls usually had a family picnic either at Grafton or Edinburg. This tradition dated way back before my time. It was always a very big affair with close to a hundred people - all relatives. Some of the original Ordahl pioneers had settled near Edinburg and the others near Grafton. In Edinburg the annual picnic was held at the home of Nick and Bessie Ordahl which was a large Victorian house. I have been told this house has been fully restored and remains an attraction in this small town. When the picnic was in Grafton it was held at the city park.

I was not very good at sports, so I did not try that much and found other things to do. I found I did like hunting and shooting firearms. However, my hunting was mostly gophers since they were plentiful. My Dad gave me his 22 rifle at age 12 and I have treasured it ever since. I still have it. I also purchased a very nice Smith and Wesson (S&W) revolver in about 1950. I yearned for it a long time and finally earned enough money picking potatoes at ten cents a bushel at nearby farms to buy it. I think that was \$60. I still have this revolver and it is my preferred gun when I go target shooting to this day. The trigger pull is finer than any others I have purchased in later years. I was also quite active with amateur

radio. I set up a small room in the basement for the equipment and enjoyed talking to other “hams.” This is a hobby that I enjoyed well into adulthood.

As a youngster around ten years old, I was always looking for odd jobs to earn a little money. This was usually mowing lawns or moving firewood. At one point when I was a teenager I worked as a handyman for Mrs. Cashel who was a widow living alone in a large Victorian type house. She had a 1939 Pontiac in the garage but since she did not drive, I sometime drove her around town in it and then usually out to the cemetery to visit her husband’s grave.

I had an Aunt and Uncle (Hegranes) that operated a dairy farm just on the edge of town not far from where we lived. There was always plenty to do there so during my high school years I did all sorts of chores and field work for them. Since it was a dairy farm, they needed straw and therefore they were one of the last farms to use the old-style threshing machine which provided an output of grain and a straw stack. This also required grain bundling which in turn required use of a binder machine. I learned to operate a binder, but it was really a very dangerous piece of equipment.

Looking back now when I was 7 to 11 years old, the WWII years were a very interesting period. Everyone pitched in with all they had. Many people had victory gardens to raise their own food. There was rationing of many regular items such as shoes and sugar. Gas for cars was rationed and many cars had governors to keep their speed to no more than 35 mph. Farmers usually were allowed as much gas as they needed to produce the crops. Periodically new ration stamp books would be distributed, and we sometimes got the day off from school since the school facility was used as a distribution site. We all collected scrap iron and rubber and took it to the collection stations. We even saved the tin foil wrappers from gum packages. I collected the discarded metal container covers from snuff boxes that had been left around on my grandfather’s farm. At one point there was a call for hunting knives. I had a very nice holstered knife but I turned it in. That was hard but I was proud when it was publicly displayed with others prior to being shipped off for the war effort. And then there were the war bonds that we all contributed to. We collected ten cent stamps in books until we had enough to buy a \$25 bond. And so it was until Victory over Japan day VJ Day in 1945. There was much dancing in the streets that day which is something everyone that was there remembers.

In the war years of 1941 to 1945, I really wanted a bicycle but a new one was not available because of the war effort. My Dad refurbished an old one for me, but I

was unhappy about the style and age. Right after the war my parents bought me a new one from the Sears catalog. I was so thrilled when it arrived. Another strong memory from this period is a great day in 1945 when I found a very nice small lost dog huddled on a neighbor's porch. I sheltered her for a few days and then saw a lost dog add in the weekly newspaper. The owner was a farmer from a farm about 12 miles to the west. The dog had followed a truck to town and became lost. I returned her to the happy owner and was offered a puppy from the next litter. And that was my new friend named Lucky. Lucky was with me and our family for many years. He died after I moved to California.

When the circus or carnival came to town it was a pretty exciting event for me and the other kids. They would set up near the edge of town and all the kids would try to get little jobs like carrying water to the animals in hope for receiving a free ticket to a show.

I traversed through the first six school grades without much to note. Things became more serious in grades seven and eight. These were taught in an old wood multistory building, maybe dating back to 1900 - not sure. The most enduring memory from this period is the English class taught by Cora Lykken. It was all about spelling and sentence structure. She was very strict, but she was good at what she did. Even so I cannot say I retained it very well.

The high school years were 1948 to 1952. During this period, I had several teachers that dramatically shaped the rest of my life. One was Harold Bliss who taught chemistry, physics and biology. He also organized the science club. In 1951-1952 he encouraged me to enter a project into the state science fair. I had a lot of help with the project and in the end, it received the first-place award. The prize was a trip to the national science fair in Washington D.C. We set up our projects at The Smithsonian Museum. Although I did not win a prize, I did have my first TV interview. Following the science fair, we visited the White House (Mrs. Truman greeted us), the Bureau of Standards, and several other museums. All of this was very impressive and caused me to think my career calling might be in engineering.

Another very influential teacher was Joe Birkland. Joe taught several courses but the key one for me was band. I played the trombone but never was much of a musician. However, the band was a great organization with much comradeship. Joe Birkland expanded the high school band into a full city marching band. His goal was to bring this to a point where the band would march in the Rose Bowl Parade. It was a tremendous planning, fund raising and training effort especially

considering Grafton was a pretty small community. But it was achieved, and the band did march in this parade January 1, 1949. Although I was very young I was fortunate to be able to be a part of that undertaking. We traveled to California by train in Pullman sleeper cars, which we stayed in at LA Union station. During our visit to Southern California we took many trips to the various tourist attractions, like Knotts Berry Farm, the Hollywood Walk of Fame and beachfront hotels. Coming from the snow and cold of North Dakota to the green hills and blue Pacific of California, this was all almost unbelievable to me. It formed an impression that has lasted my whole life. Joe Birkland also arranged similar band trips for us to other events around the country including the Orange Bowl, Mardi Gras and the Portland Rose Festival.

Before I leave this formative period, I need to also mention the influence of another teacher, Hazel Sutterlin. She taught literature and speech and at one point she convinced me to enter the speech contest. I was pretty uncertain about this but agreed. I selected one of Winston Churchill's memorable speeches, "The War of the Unknown Warriors" to recite. I recall practicing very hard to get it right and I guess I did as I was awarded first place. I think the prize was \$15 but the experience gave me skills that lasted my entire life. Speaking has turned out to be a critical skill in my career and it all started here.

During high school I didn't participate much in the social scene. Basically, I was quite shy especially around the girls. Fortunately, that changed in later years.

I now knew what I wanted to do (engineering) and where I wanted to live (California). My goals were now set. The rest was implementation.

High school graduation occurred in May 1952. That summer I was fortunate to obtain a job with the government soil conservation district as an assistant doing survey work. This primarily involved designing farm field low spot drainage ditches. This was not an easy task given how flat the land is. Sometimes there is less than a one-foot elevation change in a mile. I was able to do this again during following summers between my college years. Both the earnings and experience were very welcome.



Violet and Oscar Ordahl, my parents.



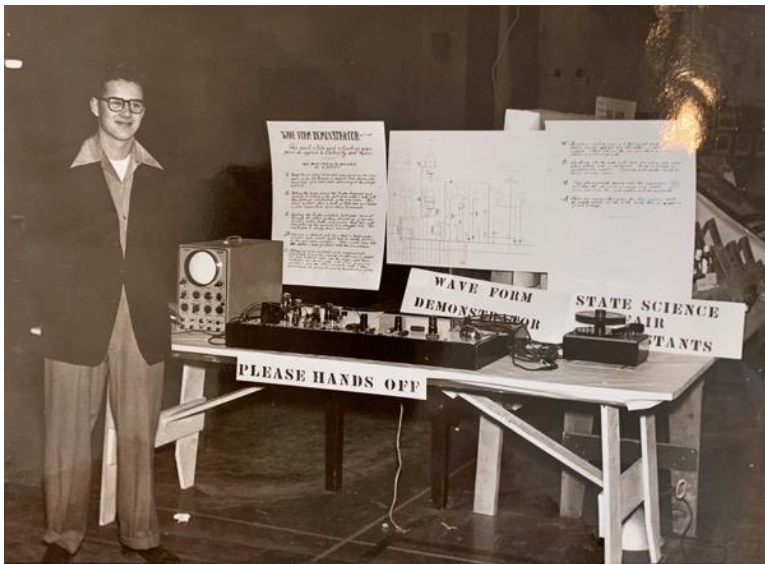
My dog Lucky with my parents



My home in Grafton, North Dakota 1934 -1956.



Family photo, about 1946



Science Fair project, 1952

Science Winner to Enter Project at National Fair

Local Organizations Vote Funds for Trip to Washington

Charles Ordahl, Grafton high school senior who won first place at the North Dakota science fair with his electrical wave form demonstrator, will display his project at Washington, D. C., May 8-9-10 and will compete at that time for national honors.

Ordahl, and his science instructor, H. N. Bliss, expect to leave May 4 or 5 for Washington. They will be joined at Grand Forks by Julian Rolzinski, science instructor at Devils Lake, who will accompany the second place winner to the national science fair. Rolzinski is a former Minto resident.

Grafton's Kiwanis and the Grafton Chamber of Commerce each voted \$100 last week in order to send Ordahl and Bliss to Washington. The state Veterans of Foreign Wars chapter also donated \$50 while the Grand Forks Herald is paying the entry fee for the two prize winners. Other local organizations are also expected to help defray expenses on the trip.

Local newspaper coverage.

Chapter 2: The College Years and Moving to California, 1952 -1956

In the summer of 1952, I filled out and submitted my application to the University of North Dakota (UND). There were no special tests and as far as I can recall they only asked that you show that you had graduated from high school. The fees and tuition were very low, at least by today's standards. I applied to the college of engineering and was accepted.

I don't think my parents made specific plans for the financial side of this, but they said they would pay for the room and board, clothing, tuition, books and fees. My mother planned to continue working so this could be afforded and she did. Generally, I was expected to earn my own money for other things, and I did.

On a Sunday in September 1952 my parents drove me to the university at Grand Forks which is about 40 miles south of Grafton and left me at the dorm where I had arranged to stay. For the first time in my life I was fully on my own. I must admit I was a bit on the frightened side. But only a bit since this was now a big new adventure. That evening I found a few new friends that were in the same boat and together we made plans for the next day.

That evening I also received invitations to visit various fraternities to evaluate them and for them to evaluate me. I decided to proceed with that process the next day. This was something I had not thought much about up to this point, but it all turned out well. In fact, it was very good for me. I found out that I would be able to live in the fraternity house as well as have my meals there. That suited me fine at least up to a point. At the completion of this process I decided to join Tau Kappa Epsilon (TKE) and they decided to take me in. Wow, this was great, and I soon became a TKE pledge and moved into the TKE house. I began to learn that there was a lot more to this going to the university than I had thought.

The TKE house was a three-story house plus some basement rooms on University Avenue. It was one of a long row of intermingled fraternity and sorority houses. It was fairly close to the end of the row so there was a fairly long walk to the campus buildings for classes but even that was just fine. I was assigned to a corner room on the second floor. Things were pretty crowded that year so there three of us in this room and since I was the last one in, I got the top level of a three-level bunk bed. This was not to my liking but there was no other choice.

I found the costs to be quite modest (around \$50 a month). This included a fixed monthly cost for room and board and a small fraternity fee. This was good and I had all my meals at the TKE house for the four years I was there. That is except Sunday evening when we would sometimes go to Whites in East Grand Forks, which was just across the Red River in Minnesota where you could get a hamburger and a beer.

As TKE pledges we each had a big brother that helped us learn the ropes. We learned the fraternity beliefs and rules. We were taught proper etiquette, table manners and other social skills. It is hard to believe now but we were taught how to properly offer a cigarette to a date or companion. Cigarettes were provided free by the tobacco companies for this purpose. Smoking was definitely encouraged. Fortunately, this part never worked for me and I never took up this habit.

Each Wednesday evening our fraternity would have dinner with a sorority. Half of us would go to their house and half of the girls would come to our house. Being somewhat shy with girls to begin with this became a forced opportunity to shake this off. It seemed to work but still pretty slowly.

To become full fraternity members (called Actives) the pledges had to go through the initiation process. The hazing or scumming process was the first part of this. This was pretty distasteful and went on for almost a week. I recall and hated the potato sack outfit we had to wear - even to class that week. At night we had to play through all sorts of crazy games that were mostly pretty bad and certainly I don't want to describe here. But I will mention one prank that might have become seriously bad but didn't. We were told to steal the eating utensils from the student union. We dutifully did it at night. We simply went in and took the stuff and brought it back to the house. No one saw us and it was all returned before anyone missed it. We got our credit and it was probably the easiest part of this process. Finally, we got to the initiation ceremony and that was all good so in the end it was all worth it.

So, over the four years, fraternity life was fun and a great learning experience. There was great comradeship in all that we did together. And while I did not participate in UND sports I greatly enjoyed going to the football, basketball and hockey events with my fraternity friends. And I also liked the beer busts. These were usually organized with a sorority and held out in the countryside somewhere. A bonfire, beer and lots of singing. Homecoming was also a big affair with the

game usually followed by a dance party at the house. Liquor was allowed at this event and usually far too much of it. It was fun but the next day was tough.

One thing that is strong in my memory is the Flicker Tail Follies, which was an amateur Broadway show type event put on by the fraternities and sororities. In my first year I was urged to participate in a tap-dancing routine. Can you imagine? But I practiced hard and it worked out okay. Now at age 85 and having successfully weathered a stroke at age 79 it seems almost inconceivable I did this. But of course, I was then only age 19. Oh, such memories!

That first semester at college and living away from home with roommates was a big adjustment. One of my roommates was a military veteran, somewhat older and more mature than I was and so that became a new adventure in itself. I thought: was this “higher education?” - I guess so. Beer was not allowed in the rooms, but we always had some out the window on the fire escape. There were always a lot of visitors in this room at all hours. It was impossible to study in this environment at night, so I tried to do my studies mostly during the daytime. I learned to sleep when I needed to even with all this activity going on. This was okay for a while but after that first semester I managed to get another room with one roommate which was much better for studying. I lived in that room the following three years.

During the early college years, I still missed home and often went home to Grafton on weekends. This usually involved hitch hiking - something that was more acceptable and less dangerous in those days. Often a friend, that was also was a TKE and owned a car, let me ride along on the forty-mile ride back to Grand Forks

I certainly remember going to classes and labs but that seems less interesting so I will not write much about it. I will say that our classes were quite small. There were only twelve in electrical engineering and only about fifty total in that years engineering class. I was an average student, had a lot of help from other classmates and managed to complete my degree in four years. I figured that was not great but adequate to meet my objective.

In 1953 the Nation was involved in the Korean War and the North Dakota National Guard had been called to active duty. Even though I was in school I was concerned about getting drafted. The National Guard was being reconstituted so I decided to join since it was unlikely to be called up again anytime soon. This involved a meeting each week and two weeks of training at a camp near Devils Lake each summer. This involved marching drills, rifle training, kitchen police (KP) duty,

guard duty and even some practice patrols at night but with blank rather than live ammunition. I recall one night a machine gun started firing on us. It was of course not real, but it sounded and felt like it was. We fired back and in the dark of night it felt pretty serious and scary. One year President Eisenhower was in North Dakota for the dedication of the new Garrison Dam. We were assigned to stand guard at each crossroad along his route. The military leaders inspected us very carefully to be sure we did not have any live ammunition. All in all, the National Guard duty worked out as planned and I successfully completed my three-year assignment in early 1956 and was transferred to the reserves for another six years. There was no draft and the Army Reserves was pretty much a non-event.

Another strong memory from this period was buying my first car. It was late in the summer of 1955; I was almost 21 years old. I found this nice-looking used Buick and had saved enough money from my summer jobs (around \$500) to buy it. I talked to my Dad to get his permission. He knew better but reluctantly agreed. So, I bought the car and unfortunately it had a poor engine. It really was not the right car and I should have known better. As it turned out Dad bailed me out. He gave me his very nice 1950 Pontiac and then traded this Buick in on a new 1955 Pontiac for the family. This was his last car as he died in 1959. But I ended up with a good 1950 Pontiac which I used the following school year and later took to California. I had learned a lesson and was very happy.

The 1955/1956 Christmas/New Year holiday period was very momentous for me. I was at home for a visit and things were going well. I was a senior in college and felt I was now able to see a successful completion of college and the beginning of a future beyond. I had overcome my shyness related to girls and I was ready to start dating. Since I now owned a car, I had more freedom to expand my horizons. A friend and I decided to take in the New Year's Eve dance at Park River - a small town west of Grafton and we went in my car. At that dance I met Eileen - my future bride. She had also, by chance, decided to attend this event with two of her friends. So, our meeting was somewhat by luck and most certainly by good fortune. Near the end of this dance I asked Eileen if I could give her a ride back to where she was living in Grafton. She agreed and that was the beginning of our relationship which has now lasted for 64 years.

After that we talked or corresponded every day. I went back to Grand Forks and Eileen went back to Fargo to continue her nursing education. But I can certainly say that nothing was ever the same. I tried to see Eileen every weekend if possible. I drove the 80 miles to Fargo and slept at the local TKE house - sometimes on the couch. I recall one Saturday there was a storm with much blowing and drifting

snow. Travel advisories were all over the radio, but I really wanted to see Eileen, so I started down the highway toward Fargo anyway. Snow was rapidly building up in drifts on the highway. As I made it through each one, I knew there was no going back - at least this day. Finally, I came upon a group of stalled cars and at that point there was no going either forward or back. Fortunately, I had a full tank of gas and the temperature was not very cold. But of course, with this being before cell phones there was no means of communications. Now being a part of this stalled cars group, I simply had to wait. And wait we did - all day long. I was able to chat with the other car owners and listen to the radio but that was about it. Finally, in the late afternoon the snowplows arrived to set us free. What should have been a journey of less than two hours took more than eight hours. But in the end, I found Eileen faithfully waiting and we went out and had a nice dinner together. Difficult as that drive was I would certainly do it again as there was a wonderful prize at the end. Although North Dakota winter weather can be severe I did not encounter this type of situation again.

My parents began to wonder what had happened to me since I was no longer showing up at home every weekend. In light of that, Eileen and I agreed we would spend one weekend in Grafton to visit friends and family and do wherever else we could find. Eileen stayed with a friend and I stayed at home. We went about town together and on Saturday evening we went to a movie at the Strand Theater. We did not find much else to do other than to drive up and down Hill Avenue (Main Street). We both agreed that the visit to Grafton was successful and with that returned to our respective schools.

The next several months were exciting for me since I had interviews for future employment, and I was making plans for the future trip to California. I spent just enough time on my studies to make sure I would successfully finish and graduate. I initially received a job offer from North American Aviation for engineering employment at their facility in Downey, Calif. The offer was \$440 per month. I did not prefer Downey, but the work seemed about right and at least it was Southern California. I accepted the offer since at that point it was the only one I had from Southern California. However, several weeks later I received a similar offer from the Douglas Aircraft Company in Santa Monica. This was by far my preferred location and also it was for slightly higher compensation - \$450 per month. Douglas had given me a little more credit for my surveying work experience. It was not hard for me to reject the North American Aviation offer and accept the one from Douglas. In addition, the offer included paying expenses for moving to California. This was all wonderful and I felt I was exactly on plan.

Douglas sent a check for the travel expenses as soon as I accepted along with instructions to report in on June 13, 1956.

My UND graduation occurred on June 3, 1956. I left for California the following day. In order to help this process, my Mother decided to drive with me, and my grandfather too. They planned to visit my aunt in Monrovia for a short time and then return to ND by bus - which they did. With the Pontiac now packed I said goodbye to Eileen and my Dad and we departed. The trip to California was relatively uneventful and we arrived at my aunt's house a few days later. As planned, we stayed there several days and visited some of the local attractions. One day we went to the beach at Santa Monica. I recall one day I was walking along Colorado Boulevard in Pasadena and saw a gull winged Mercedes coupe in the dealer's show room. I think the price was \$5000. This looked like the right car for California and maybe for me. But I was too practical for that and passed it by. But I still wonder - What if?

Anyway, the following Sunday my mother and aunt drove me to Santa Monica where I found a small hotel room in which to live for a few days. They left me there and returned to Monrovia. I was now alone again but the next few days would be terrific as I start my new job at Douglas.

The one challenge at this time was that Eileen was still in school in Fargo. Fortunately for me she solved this as she has so often has done throughout our life. She arranged to transfer to a nursing school in the fall in San Bernardino, California which is approximately fifty miles east of Santa Monica. Things began to fall into place as her mother, Amelia, decided to also move to California later that summer since Eileen's brother Alton was also living in Southern California. Eileen was then able to live with her mother in an apartment in San Bernardino near her new school. While she could have selected a school in Santa Barbara, she selected San Bernardino so she could be close to me.

...ning for the act are members of Gamma Phi Beta sorority and Sigma Chi frate
the picture above, Linnea Hanson of Bismarck and Trevor Rowland of Grand
in front while in the back (left to right) are Carole LaFrance of Bismarck, Roland
Park River, Virginia Black of Grand Forks and Ross Halliday of Kenmare. (H
Photo).



KAPPA EPSILON fraternity men, better known as the Tekes, warm up for the Flick
Follies all-campus variety show set May 4-6 with a practice session in the fraternit
e. Pictured in action in a dance routine (left to right) are Donald Lovegren of Gre
s, Alan Leupp of Mayville, Don Sheridan of Grand Forks, Gary Jenkins of Elk Riv
., Charles Ordahl of Grafton and Orrin Bergan of Maddock. The title of the Teke ac
"Reflections in Rhythm." (Herald Photo).

College fraternity group singing for the Flicker Tail Follies



Graduation photo in front on TKE house, 1956

Chapter 3: Starting out at Douglas Aircraft - June 1956

In 1956 the Douglas Aircraft Company was a sprawling facility on Ocean Park Blvd. in Santa Monica. It had been built and expanded for WWII work. My employment was to start in building 41 on the rear side of the facility near the parking lot. The entire facility was surrounded by a chain link fence with only a few guarded entrances. My instructions were to report to the gate near bldg. 41 at 8 AM on June 13. It was an easy drive from my hotel, and I had no problem parking and finding this gate. Once there I found a number of other young engineering new hires and that morning, we all formed a line leading to the entrance. The weather was very nice, as it usually is in Santa Monica, so there was no problem waiting in that line. Before long some HR people arrived to check us in through the gate and lead us to the building 41 upper floor office area. The first floor was a missile production area largely used for Nike missile production at that time.

Douglas had just recently received two major missile program contracts - one being the Thor intermediate range ballistic missile (IRBM) and the other the Nike Zeus. All of us were assigned to one or the other of these programs with selection being mostly by chance since they both needed all the engineers they could get. I was assigned to the Thor IRBM project.

Next, we were greeted by our new supervisors. In my case I was assigned to the electrical equipment group and my group engineer (supervisor) was Jim Dorrenbacher. Jim was about seven years older than me but far more experienced and a steely-eyed missile man (at least to me). He had been a key member of the Nike development team and was now assigned to the new Thor IRBM program. He became a friend and close mentor throughout most of my career.

Jim took me to the engineering office area. There was sea of drafting tables and I was assigned to one and introduced to others around this new work area. Each table had the appropriate drafting equipment and there was one telephone for four people. This was pretty standard for that era and certainly okay by me. Us new engineers had confidential clearances which was a step in the process to receiving a secret clearance. Most of the Thor work was of secret classification at that time and being conducted behind closed walls separate from the area I was initially assigned to. There was an armed guard at the entrance to the secret work area. Never-the-less there was a limited amount of work that was assigned to those of us with only the confidential clearances.

My first assignment was to make the drawings for a bracket to hold some missile electronic equipment. Basically, draftsman's work. I thought and wondered why one needed an electrical engineering degree to do this. But of course, I completed the task and in the end I was proud of this small role in that very early phase of the Thor development.

I find it interesting to recall that working on Thor required working a 48-hour work week. This was comprised of working 8.8 hours per day (M-F) plus 8 hours every other Saturday. I figured this was just fine since we were paid an overtime rate which brought my actual initial salary to about \$512 per month. Because of the priority and schedule there were times when this was increased to a 52-hour work week. The pace of this program was definitely increasing.

At this point I still had to find a more permanent place to live. I found another classmate from UND (Roger Brant) that was also looking for living space. We decided to do this together for the summer since he planned to return to UND in the fall. But it was very difficult to find an apartment that summer. We eventually found a small studio type place on Sawtelle Ave in West Los Angeles. It wasn't great but was acceptable.

Most of that summer, when not working, I spent time exploring the LA area or going to the beach. This was a wonderful new experience and I wrote letters to Eileen, who was still in Fargo, almost daily telling her about it with anticipation that she would soon join me for more of the same. This was now the great California lifestyle I had long been seeking.

The summer of 1956 passed slowly but I finally got my secret clearance and even better than that, Eileen arrived in August. She joined her mother in San Bernardino and I started visiting them every weekend- time permitting. Together Eileen and I started to further explore our new environment, we even went to the bull fights in Tijuana, Mexico.

Around August I found another larger apartment on Federal Ave. that I rented with some other friends from ND. This one was much closer to the Douglas facility and I remained there until about mid-1957 when several of us moved to a place closer to the ocean.

At work I moved into the enclosed secret Thor design area and began more complex engineering work - much more to my liking.



Day trip to Tijuana, Mexico.



Eileen, student nurse.

Chapter 4: Thor IRBM Program (Development) 1956 -1957

In the mid 1950's the Nation was in a standoff with the USSR. The USSR had obtained the hydrogen bomb and both nations were working to develop a long-range ballistic missile capable of delivering such a weapon into the others homeland. For the US that was the Atlas - a 5000-mile range missile Inter Continental Ballistic Missile (ICBM). However, there was great concern that the USSR might be making faster progress on their ICBM than the US was on the Atlas. That fear was called the "missile gap." To address that perceived gap the US decided in 1955 to develop an intermediate range ballistic missile (IRBM) that could be deployed in countries such as England or Turkey and thereby be able to reach targets in the USSR. Because of the size scale the IRBM could be brought to operational status faster than the ICBM. Two IRBM missile programs were authorized by Congress and implemented with contracts awarded near the end of 1955. One was the Jupiter, managed by the Army, and one was the Thor, managed by the Air Force. Each was specified to have a minimum range of 1500 miles and were to use technology such as the engines and other complex elements already being developed for the Atlas. The Thor contract was awarded to Douglas at the end of December 1955. This work was given the highest defense program priority (DX).

Douglas formed its' Missiles Division at the end of 1955 to manage the development and production of both the Thor and Nike series missiles including Zeus. The leader of this new division was Robert L. (Bob) Johnson. He was a great engineer, outstanding leader and a very fine gentleman. He also became a mentor. Coming into this new division in June 1956 I was an early team member. Again, I found myself in the right place at the right time.

By August 1956 the Thor missile development and first missile production was moving at a fast and furious pace. At that time, I was designing engine test and firing circuits and I was now clearly using my education. I still have the original engine test panel that I designed which was presented to me at one of my retirements.

In October 1956 the first Thor (101) was ready for shipment to the Cape Canaveral Florida test site. Jim Dorrenbacher asked me to go to Florida at that time to assist with testing of this first missile. That experience is my most vivid recollection of this period.

In that early period, engineers were expected to travel to Florida in a military plane configured to carry both passengers and equipment. On a Sunday afternoon we boarded at LAX and flew to San Diego to pick up some cargo. From there we flew to Denver to pick up additional passengers. They were late to arrive but since they were VIPs we waited and waited and waited. Finally, they got there, and we took off for Patrick AFB, Florida. When we finally arrived in Florida the Monday sun was already rising. What a trip! But that was only the beginning.

From Patrick AFB we went to the Douglas administrative office to get our badges and be assigned a place to live. The badging went ok but when it came to a place to stay there just were not any at least for the next night. I began to worry as time wore on. Eventually they managed to find me a bed in the manager's room of a nearby hotel for that first night only. That worked out okay but then I had to move to another place for the following period. That turned out to be in Titusville which is a few miles north of the missile test site. Since things were so crowded, we doubled up two to a room. That was alright especially since I got assigned to the night shift and my roommate worked on the day shift. This arrangement worked out quite well since if I had some extra time during the day I could relax by the pool and watch the boats go by on the inter-coastal waterway which was very nice.

Back at work I was assigned to missile 101 testing in Hanger M. Since I was working at night it was mostly propulsion system testing. My task at that time was pretty easy, simply providing electrical operation of the valves and some occasional trouble shooting. But at night the bugs both in and out of that building were terrible. One time an insect control spray truck came by. They called us to get out and then proceeded to fill the entire hanger with bug poison spray - missile and all. And so, it was. As far as I know no one was hurt and the missile was not damaged. It did seem to do a job on the bugs. On Halloween night we were not very busy, and Jim Dorrenbacher came by and together we went to a Coco Beach restaurant for some beer, to tell stories and have some fun - Jim said; it was all part of getting more experience. I was for that. He then took me back to Hanger M. He drove too fast but nothing else happened including not much more work that night. We had to pay back to the schedule with more intense work in the following days and nights.

Since we made good progress with the propulsion system testing, I was then reassigned to the day shift to design and test the service tower and blockhouse communications system. I was not terribly proud of the results since the system had cross talk that was very difficult to eliminate. With some additional help I

finally got that resolved and it was used for the launch pad missile testing and the launch.

One night another engineer and I went down to our launch complex 17 to watch a missile launch from an adjacent launch complex 18. These launch pads were pretty close together so I am not sure we should have been doing this, but no one stopped us, so we did. The missile was a Redstone, and this was my first opportunity to watch an actual launch. We climbed to the roof of our blockhouse to get a better view, so we were pretty darn exposed. But again no one stopped us, so we did it. This turned out to be very exciting to say the least. The missile took off and it immediately had a control failure which caused it to turn inland instead of going down range. It turned and flew in an arc over head with some pieces falling off. This was so unexpected and happened so quickly that we did not try to take cover but simply watched in awe. The missile continued until it crashed about a mile away with a huge explosion and a very large shock wave. Fortunately, the range safety officer for one reason or another chose not to send the destruct command. We were probably very much at risk had he done so. The lesson learned is: Be careful, these things have a huge amount of energy. I will never forget that experience.

A few days later Jim told me I should take a break and go back to California. In a way I hated to leave the place of all this excitement, but I did yearn to see Eileen. I had written to her almost every day but that doesn't come close to actually being together. I was soon on my way. By this time, we had been authorized to fly by commercial air and my flight had a plane change in Atlanta. As I waited in the terminal, I sat down in one of the closest seats. Shortly thereafter a large man came over and said to me "Son, you are sitting in the wrong seat," meaning I had unknowingly sat in a section reserved for people with skin of a different color. Being from North Dakota and California this was my first encounter with segregation as it existed in the South at that time. But for that day I simply complied and was soon on my next flight to Los Angeles. Once back home I found my car had a flat tire, but I changed that for the spare and was soon off to San Bernardino to see Eileen that same day.

I did not return to Florida for the launch of Thor 101 which occurred in January 1957. Unfortunately, it failed shortly after liftoff and exploded back on the launch pad. Such events were not uncommon in those days and so we got on with repairing the launch pad and launching another missile. It took us five launches to finally get a Thor missile to fly the full range. It was now mid-1957 and this was

considered a major success as the Nation now had a strategic IRBM to counter the USSR.

But, there was still much to be done to make this a fully operational system. I soon became a part of the effort to make that happen.



Thor 101, 1957



Electrical equipment panel I designed – it was used for Thor and Delta propulsion system testing, 1956-1970

Chapter 5: Getting Married – 1957

At Christmas time in 1956, I purchased an engagement ring for Eileen and gave it to her in the car right before the Douglas Aircraft Christmas party. Although I didn't formally propose, we both assumed we'd be married when Eileen's schedule permitted. By mid-1957 things were moving along fairly well for both Eileen and me. But this was not to last very long since we decided to get married even though Eileen had not yet finished nursing school. We developed a plan for how to accomplish this. Her schedule starting in November included two temporary three-month assignments, the first at the Veterans Hospital in West LA followed the second at Children's Hospital in Oakland. After this her nursing education would essentially be complete. Since I was living in Santa Monica, after we got married, we could live together there as the Veteran's hospital was close by. Her second assignment to Children's Hospital in Oakland, California would require her to live in Oakland for three months but that was going to be necessary whether married or not. By November I would also have sufficient work vacation time accumulated. This plan seemed acceptable to both of us, so we decided to marry in early November at the nearby Lutheran church. We informed our parents and started making further arrangements.

My parents came from North Dakota by bus for the wedding and for Dad it was his last trip to California. Eileen's Mother was of course already here, and her Father had passed away in 1954. The wedding took place at a small church in San Bernardino near where Eileen lived and was attended by family and friends.

Following the wedding we traveled in our trusty 1950 Pontiac to Lake Arrowhead Village where we had decided to stay that first night. This was only a few miles up the mountain from San Bernardino. That worked out fine however there was an early snow and freeze at Arrowhead that year and since I had forgotten to put antifreeze in the car radiator, I became concerned about engine damage. Thinking back, I now wonder how a guy from North Dakota could forget something like this. Anyway, to remove this concern we decided to travel on to Las Vegas the next day. Following a nice time in Vegas we returned to our apartment in Santa Monica to begin our married life together.

As time went on things pretty much followed the plan. Eileen drove the Pontiac to the West LA Veterans hospital, and I took the bus to work or caught a ride with a

friend. During this period the USSR Sputnik satellite launch occurred which further underscored the work I was doing at Douglas.

After Eileen went to Oakland we talked and corresponded every day following our now well-established practice. I made one weekend trip to Oakland during which we took in a night club tour which was a lot of fun. Eileen made one weekend trip back to Santa Monica and then the assignment was over.

Eileen spent a little more time in San Bernardino and then graduated. We were both very happy as we expected good times ahead. We continued to live in the Santa Monica apartment until it was time to leave for England.



November 3, 1957 San Bernardino, California

Chapter 6: Thor IRBM Operational Deployment and Project Emily, 1958-1960

In about the first quarter of 1957 a decision was made to proceed with development of the Thor operational support system. The requirement was for the equipment be air transportable and be able to launch the missile within 15 minutes. The project was to be implemented using a scheduling concept called “concurrency” - that is activities normally done sequentially were now being done in parallel - a recipe for errors and there were many.

A design team was formed, and I was assigned to this team about mid-1957. Thor was a liquid propellant missile and the short launch readiness time required full automation of the launch sequence including transfer of the propellants. This was a significant challenge as nothing similar had been done before. My task was to design the electrical circuits for this Propellant Transfer System (PTS) and assist with integration into the overall launch system. There was significant risk. The PTS testing was being conducted at the Sacramento test site. One day, an explosion occurred that killed four people. The cause was use of 100 percent pure gaseous oxygen to pressurize the liquid oxygen (LOX) storage tank. Fortunately, I was not there that day. One may recall that a decade later three Apollo astronauts were killed by a fire when 100 percent oxygen was used to pressurize their cabin which was the same root cause. It is sad that this lesson had to be learned more than once.

In about April of 1958, Jim Dorrenbacher asked me to go to England to work on the installation and checkout of the operational Thor system. The project was given the code name “Emily.” I had been planning to go back to school at the University of the California at Berkley for my master’s in electrical engineering, however I knew they needed me in England, so after discussing this with Eileen I agreed to take the assignment. Eileen was still in school however so it was agreed that we could wait until after she finished her state board exams in August before traveling.

So, in August 1958 we packed our belonging, sold the Pontiac and departed on this new adventure. We joined the weekly charter flight to England which was a prop aircraft since jets were not yet in service. The flight was long with one stop for refueling. We landed at Lakenheath AFB, East Anglia, the next morning tired but

happy. We were then transported by bus to the Greensboro hotel in Cambridge. Our hotel was dark and damp, so we moved on as soon as possible.

At this point we did not have a car, so I took a chartered bus to work. Eileen stayed in Cambridge. I had to get up very early and the bus was old and slow. The work location was Feltwell which was a RAF base and the planned location of the first Thor missile emplacement. Most of the missiles were to be located in East Anglia airfields that had been used for the WWII RAF bomber force.

Initially the Douglas organization chartered to accomplish this work was very disorganized. It was assumed that this was like a production line, but it was actually far from that. The engineers were told to stay in the office unless called. Soon there were so many problems that all progress stopped. When this was recognized changes were made to get the engineers more involved in an attempt to get through these very serious difficulties, but still we had a situation where very few things fit or functioned properly. One day the new management called a meeting to discuss ideas on what we should do. I thought long and hard before I raised my hand. Finally, I decided I had to. I told them I had brought a box of drawings with me that I knew were far closer to the correct configuration than the unworkable stuff that had been delivered. I further explained that I felt the equipment could be modified to match these drawings giving us a much better possibility of getting the system operating somewhere much closer to the requirements. There were no other reasonable ideas on what to do.

Given this terrible situation the leadership decided to do what I had suggested. They asked me to organize an engineering team to write the engineering orders to direct this work while they organized a team of technicians to implement. The engineers worked very long hours and the technicians worked three shifts around the clock to accomplish the task. Thinking about this now I can hardly believe this actually happened - but it did. A 24-year-old kid was issuing instructions that would lead the Nation's highest priority defense program out of its troubles. We were able to meet the December 1958 first emplacement completion goal and the entire first squadron of 15 missile sites was modified to the redesigns we released in those engineering orders.

During this period Eileen was able to get a secret clearance and this allowed her to initially get a job with Douglas in accounting and later as a company nurse. She liked the nursing job far more than the accounting job.

I could go on with more of this work history, but I think the things we did outside work may be more interesting. It is probably sufficient to say that the system installation and checkout continued with new problems being resolved along the way and the entire 60 missile emplacements by early 1960. When all was said and done the Thor stood tall and strong in the Nation's defense from that time on through the Cuban missile crisis in 1962. It was decommissioned after that and most of the hardware was returned to the US to be used later in the space program.

We really enjoyed our car once we got it which was about six weeks after our arrival in England. It was a black 1958 Volkswagen. We purchased it through the Base Exchange (about \$1150) and it was delivered from Germany to the English port city of Ipswich. One Saturday Eileen and I traveled by train to Ipswich to pick it up. Train travel itself was an experience. The locomotive burned coal and when going through tunnels the smoke infiltrated the passenger cars which was not good. But we arrived safely at Ipswich and found the car dealer. This Volkswagen met all our expectations and we were so happy to now be able travel at will about the English countryside. And we did so starting that very day. On the way back home, we stopped at the AFB for a hamburger to celebrate which was simple but good.

Beyond work, our life in England during these 18 months was quite interesting and we had considerable fun. Eileen and I continued to look for better living quarters than that first hotel. Not much was available given the large influx of new Americans into East Anglia. Eventually we were able to rent a small two room upstairs apartment in an English home in the village of Stetchworth, which was several miles from Newmarket. Newmarket is a horse racing town and is located on the road from Cambridge to RAF Feltwell. By this time, we had our VW so we drove this route to work. Our apartment consisted of a small sitting room and a larger bedroom. There was no heating other than a small fireplace in the sitting room. Coal was used for fuel. The kitchen and bathroom, which we were allowed to share with owner, were downstairs. The owner was a very nice English woman (named Kitty) along with her son and two German shepherd dogs. When we needed to use the bathroom, we had to go through seven doors and usually trip over two dogs. These surroundings were generally clean and friendly and clearly much better than the hotel in Cambridge.

I recall one weekend we drove to London in our car. It snowed and on the return journey the road to Stetchworth had not been plowed but it was usable, and we made the first car tracks. The moon was full, and we thoroughly enjoyed the drive

that night. When we arrived home, we found that Kitty had made a very inviting fire in our sitting room fireplace. It is interesting to recall that the coal was hand delivered by the sack each week.

Another recollection is about Christmas that year (1958). We bought a Christmas tree and decorations at the Base Exchange and arranged it in our sitting room. This was simple but nice and was the talk of the village. Numerous local people came by to see it. It seems that the electric lights on the tree were the main attraction. I think it is appropriate to mention that this was now only a few years after WWII and the hardships of that period were still very strong in the English people's memories.

In order to alleviate the shortage of housing, trailer houses were built for the Emily team but of course they were late, and assignment was in a priority order. The trailers were installed together in what became a company town. There were streets, utilities and the trailers were separated by just a little more space than necessary to park a car.

We eventually got a one-bedroom trailer and were very satisfied with its American style appliances, furnishing and especially heating. We parked our Volkswagen outside, and we were all set. All our work associates lived close by, so we often had parties with much talking and singing but not much space for dancing. At one party I recall the local butcher stopped in on his route through the town. He joined the party and never got any further that evening. On a following day he offered to take the guys for an English working man's night out. Several of us accepted and we played snooker, darts, drank beer and had fish and chips. This was a great experience.

Our gang frequented the English pubs quite often. The usual fare was beer, darts and singing. The English seemed to like the American songs.

Eileen primarily worked at a medical trailer in the project trailer town. She had the support of a visiting English doctor and primarily tended to rather minor illnesses and gave various shots. This medical trailer also seemed to become a local news center as many people stopped by for medical and other reasons. A memorable occasion came about from Eileen's work when the English doctor invited us to attend a fox hunt on New Year's Day. It was interesting to watch the horses, riders and dogs. I don't recall actually seeing the fox. After the hunt we joined our host

and his many guests for a party and the traditional glass of sherry. Oh, we thought we were really living the life.

Shortly after we moved into the trailer, we got a dog. He was a beautiful cocker spaniel and we named him “Marky”. He loved to run in the wide-open fields of grass near our trailer town. He liked to ride in the car and after a while he insisted on a ride each weekend. At some point near the end of our tour he disappeared. We tried hard to find him but could not. Hopefully he was taken in by a good English family.

Once we had the car Eileen and I traveled widely across England and Scotland visiting the various castles, museums and other attractions. We took two trips to the continent and visited most of the Western European countries. Eileen’s favorite was the Keukenhof flower gardens in Holland while my favorite was the Rhine River boat trip and another fun trip was our weekend at Lake .

But when we reached the 18-month point, we were ready to go home to the USA. Eighteen months was significant since at that point we did not owe income taxes on our earnings. Overall this assignment gave us a wealth of experiences and certainly helped us get off on the right foot financially. We took another tour of the continent on our way home. We had one last memorable visit to Copenhagen and then headed back to the USA. Eileen’s mother and brother met us at LAX. That reunion and everything we saw back in the USA was wonderful.



Operational Thor Emplacement RAF Feltwell, 1958



Eileen going to work 1959, England



Eileen with Marky, England 1959



Inside our trailer, East Anglia, England 1959



Lake Windemere, England 1959.

Chapter 7: Children and Our First House, 1960 – 1965

Eileen and I returned from England in February 1960. Our next step was to find an apartment in which to live temporarily while looking for a new house. The one we found was near the Douglas Santa Monica facility. Once we were settled, we had considerable time available to seek a new home and we did so each weekend. Real estate in the Santa Monica area was quite expensive even in those days, so we decided to look out in the West San Fernando Valley. At that time this area was mostly agricultural fields with housing developments being implemented here and there. It was easy to go from one to another and look through their model houses. Eventually we selected a single-story model along with the lot and signed the purchase contract. The location was Canoga Park and the house was still to be constructed over the next few months. It had three bedrooms and two bathrooms and was about 1500 square feet in size. This was an exciting time and we drove out there many weekends to see the construction progress. We would usually take lunch along, eat it in the partially constructed house and talk and dream of the future. Also, early in this period we learned that Eileen was pregnant and we would have a new family member in October. So, there was a lot to think and dream about.

The new house was completed in early summer and we moved in as soon as we could, which was about June 1960. There was much to be done. Eileen worked on the furnishings while I worked on the landscaping, which I completed myself. The summer weather in the “Valley” is very hot so this was not an easy task. But together we worked hard to complete these things before the expected new arrival and by October things were pretty much in place.

The commute to work was quite long (about 25-30 miles) and across the Santa Monica Mountain range. In the earliest years I usually took the Topanga Canyon route, which was the shortest distance, but it was a narrow mountain road leading to the coast and fairly dangerous. The other route was through the Sepulveda Pass, which was a bit shorter but there was more traffic. Either way the commute time was about 45 minutes each direction. In later years a freeway was built through the Sepulveda Pass so that became the best route.

About this same time Eileen’s mother moved to an apartment nearby. Since we still only had one car, we often borrowed her car - a 1955 Pontiac. Our car remained the 1958 Volkswagen that we had brought back from England.

One day in late October Eileen told me the time had arrived. She had been seeing

a doctor in Santa Monica so the planned hospital for the birth was in Santa Monica. We had the Pontiac that day, so we used it to drive over the Santa Monica Mountains to the hospital. Eileen's labor was quite long spanning about 24 hours. Our first child, Charlotte, was born very near the end of October 28, 1960 - also my birthday. This was the date Eileen had in mind and she achieved it. What a wonderful gift to me. A few days later there were now three of us in our new house in Canoga Park.

In 1962 when Charlotte was about 18 months old, we made a return trip to North Dakota for my sister's wedding and to visit family and friends. After our return home Eileen started work as the medication and treatment nurse at a small hospital near home. She preferred working with the newborn babies and their mothers and therefore later transferred to a new hospital where she worked in the newborn nursery. Eileen's mother cared for Charlotte during the periods when Eileen and I were at work.

There were no new notable personal events until 1963 when we decided to buy a mountain cabin. We always have liked the mountains, especially in Southern California. The change in seasons always offered so much. We were pretty familiar with the San Bernardino Mountains so that is where we started looking for this cabin even though this area was a fairly long drive from Canoga Park. We found this wonderful little cabin in Running Springs and decided to purchase it for \$9800. It was only about 650 square feet in size, but the living room had a very nice large granite fireplace along with a high open beamed ceiling. The kitchen and two sleeping areas were small but adequate for our needs. It was located on a corner lot with some large pine trees and the elevation was about 6100 Feet. We simply loved this place. We owned it until 1977. There was always a lot to do to maintain a second home like this, but we felt that was part of the experience. At this elevation there was usually a lot of snow so plenty of winter activities. Of course, there was also the task of taking the kids outerwear on and off. In the summer we often went fishing in the nearby lakes. The cabin was about a two- and one-half hour drive from our Canoga Park home and we often went there for a weekend and sometimes for a week or so. We always had a station wagon type vehicle in this period to transport us and a lot of stuff on these trips. I would usually drive going to the cabin and Eileen often drove going home.

But back at Canoga Park in the 1960-1965 period life went on pretty much as planned. We joined and attended the Lutheran church which was within walking distance from our house. The summer weather was very hot and we (especially Eileen) yearned for a cooler coastal location but that was still to be sometime in the

future. We went about our daily lives of work and play while continuing to plan for a second child. This event happened in June 1965 when our son Kevin was born and this time the hospital was only a few miles away in Van Nuys. Just prior to Kevin's birth Eileen resigned from her hospital job and then spent full time at home caring for our two children as well as me.

Sometime around 1966 we decided to buy a boat. We found a very nice used 18-foot Glasspar Seafair sedan model with a 75 HP outboard motor and a small cabin. We stored it on its trailer adjacent to our garage in the back yard and it served us very well for many years. We generally used it in the ocean and one summer we kept it at Big Bear Lake not far from the cabin. In later years we took it to Mission Bay in San Diego. However, about 1967 we had one very memorable and very scary (mostly Eileen) experience. One weekend there was an organized boating event at Catalina Island. We decided to use our boat to travel the 20 or so miles of ocean from Marina Del Ray and attend. We traveled with a friend who had a second boat of similar size. That day the red flag warning was up but the weather was sunny and fair and on leaving the harbor we found that the ocean was relatively smooth but had huge swells. As we continued our ocean journey became one of driving our small boats up and down these large swells on the course to Catalina. Eileen was quite frightened and screamed we were about to make our children orphans. She really wanted to turn back, but I persisted to go on. It took a long time but we finally arrived at the Catalina harbor. However, Eileen insisted she would not return to the mainland on our boat no matter what. She said we had been lucky, but she would not test that again. She arranged to take an aircraft flight back and that was that - period. As it turned out the sea calmed down and was flat as glass for the return trip on the following day. Although Eileen was not along, I had a great time on the return trip as I was able to travel at near top speed and reached Marina Del Ray in less than an hour. Never-the-less in thinking about this now I do agree she was more right than I was.

In this period there were not many other major events in our personal lives until 1969 when there was much turmoil at work which greatly affected almost everything in our lives from that point on.



Pacific Coast Highway, Malibu California



Canoga Park house with baby Charlotte, 1961



Leaving for the Christmas party.



Our first boat, Marina del Ray preparing for the Catalina trip.



Our first mountain cabin, Running Springs, CA in winter 1964.



Kevin helping me cut wood at the Cabin 1968.



Kevin helping me paint at the cabin.

Chapter 8: Skybolt Program, 1960 – 1962

During the early part of 1960 much of the Thor operational program had been completed and work at the Douglas Missiles and Space Division had significantly diminished from the earlier hectic pace. Douglas had submitted two major proposals for new contracts and was awaiting the results. In about May both of these were awarded. One was for the Saturn SIV-B stage (third stage of the Apollo program Saturn rocket) and the other was for the Skybolt program. These were both large programs and Douglas was once again looking for all the engineers they could get. I think it appropriate to note this was still in the era before there was wide scale use of personal computers which have subsequently vastly increased productivity. The number of engineers working on both of these programs eventually was quite large. In any case in about May 1960 I was assigned to the Skybolt Program. The organizational arrangement was for the Skybolt team to work in Santa Monica while the Saturn SIV-B team would eventually move to a new facility being built in Huntington Beach. I was quite satisfied as Eileen and I had planned for this with our house purchase in Canoga Park.

In 1960 the Nation was still in the process of developing its ICBM strategic deterrent strategy and forces. This strategy initially involved a triad of land, sea and airborne ICBMs. Skybolt was conceived to form the airborne part of this triad. Skybolt was designed to be a three-stage solid motor inertially guided missile carried by B-52 bombers on long duration standby missions around the clock. The plan was for each B-52 to carry four missiles. In addition, the plans called for carrying the missiles on UK Vulcan bombers.

During this period my boss was Ken Francis. Ken had been in the Electronics organization several years longer than me and he was also a good personal friend. We occasionally spent weekends together at Lake Mead. Once when we were spending a weekend on his pontoon boat, we paused in the middle of the lake on our way back to camp. A sudden windstorm came up and started blowing the houseboat with the women away from those of us in the water. Ken tried to swim after the houseboat but it was moving far faster than he could swim. The women threw life preservers to Ken and were eventually able to start the houseboat and retrieve us all. It was a scary experience for all of us.

In 1960 my initial Skybolt assignment was to lead the engineers in design of missile test equipment. Later that same year my assignment was expanded to

include design of the airborne support equipment (ASE) used to supply power and monitor and launch the missile. This was a pretty significant amount of responsibility and in line with that I was promoted to "Supervisor". In those days people at this level and above received and wore a "short badge." Almost everyone hoped to someday reach this level and of course I was no different in that regard. I now had leadership responsibility for about 50 engineers. This was certainly a reason for celebration and a group of us did so after work at one of the local bars. We celebrated in excess to the degree that we were asked to leave. That was not good, but I will say that we all were still pretty young and still occasionally acted like college kids. This never happened again. Several years later Douglas decided this short badge symbol was no longer appropriate and it was eliminated.

The missile development flight test plan involved some extended missile carry flights followed by missile drop tests and four programmed flight rounds. The remainder was a number of full inertially guided flights. These flight tests required that the aircraft fly a triangular path over the US and then fly a path onto the Eastern test range for the missile drop and flight. The carry flights went pretty well however my team had trouble with the motor thermal control unit, and it took us a long time to resolve this. The drop tests went well however the programmed flights uncovered a motor ignition issue which marred that test phase, but this was satisfactorily resolved in time to prevent any major schedule impact. The most significant milestone that we were all striving for was the first full up inertially guided flight. This configuration also required the full set of aircraft electronics for which I was responsible. Unfortunately, we experienced another thermal problem in one of the main Airborne Support Equipment (ASE) units that caused the cockpit indicators to act erratically which of course was very unsatisfactory. We should have found and fixed this before we got to the flight test phase, but we did not. This was part of the reason I spent more time than expected at Eglin AFB, Florida which was the home location for the flight test aircraft.

I worked at Eglin AFB in October 1962, which some will recall as the time of the Cuban missile crisis. It was a very tense time for the Nation, and I can vividly recall seeing the troops camped on the airfield ready for an invasion of Cuba should that be required. Fortunately, the crisis was resolved without that, but it truly was a very frightening time.

In any case we were able to get the indicator problem sufficiently under control so that the first guided missile could remain on schedule for December.

Just before Christmas 1962 we were all set for this very important flight test. Little did we know that major decisions for this program were happening in Washington D.C. There was an unexpected climax to come and soon. The top government decision makers were studying the strategic necessity of the full ICBM triad in the face of its very high cost. These studies indicated that the defense strategy would still be adequate without the airborne leg (which was Skybolt). On the basis of this, President Kennedy decided to cancel the Skybolt program. For most of the chain of command this was abrupt and unexpected. We were ready for this important test flight at almost exactly the same time. As it turned out the program cancellation did not get issued in time to stop the flight test. It was unclear whether this was by intent or just the time it takes for things of this sort. So, the Skybolt first full guided flight test took place as planned and was 100 percent successful. But along with the program cancellation this was certainly a bittersweet situation for everyone. When the press simultaneously reported the success along with the cancellation the President was not happy and no one else was either.

This program cancellation was a shock and a pretty lousy Christmas present. In the face of this the Douglas Missiles and Space Division management had to take rather immediate action regarding all the Skybolt employees. This was my first experience with such a shocking event and of course like everyone else I wondered “what is going to happen to me”? Fortunately, there was considerable demand for help by other programs so there were very few actual layoffs. Many of our team were reassigned to the SIV-B program but this also required a rapid transfer to Huntington Beach. This might be considered good or not so good depending on where one lived or wanted to live. I was fortunate again since I was re-assigned a supervisory position leading the ground support electronics for the Delta and Thor Space Applications programs. This was indeed a good fit for my experience and these programs were to remain at Santa Monica, at least for now. Again, I found despite it all I was at the right place at the right time.

Chapter 9: Early Military Space Programs 1962 – 1972

In the early 1960s the Thor missile took on a new role for the emerging “space age.” Some of these Thors were newly built while other were decommissioned missiles brought back from England. From here on these were no longer missiles but rather more complex multistage rockets usually referred to as space launch vehicles. These launch vehicles were used to carry important payloads and satellites into earth orbit. In these early years, Thor became known as the “workhorse launch vehicle” of the space age. There were several of these programs that became primary activities for me after the Skybolt cancellation.

One of the main new military launch vehicles of that era was the Thor Agena. This vehicle was usually a two-stage configuration consisting of a Thor first stage built by Douglas and a second stage built by Lockheed. One of the most important projects for this vehicle was “Corona” (but this was not the virus). The Corona mission was reconnaissance surveillance from earth orbit with the satellites being placed in low polar earth orbit by a launch from Vandenberg Air Force base (VAFB). Being in this low orbit they had a short useful life and required frequent and rapid replacement. My responsibility was the launch equipment at VAFB and we used the same design as the operational Thor system in England since it fit this application very well. In fact, some decommissioned equipment was returned from England and reinstalled at VAFB for this purpose. If I recall correctly, at one time we had seven of these launch equipment systems at VAFB being used for Corona. At times we launched three missions per month. One year we launched thirty-six missions and during a period of several years the Thor achieved 100 consecutive successful flights, which at that time was unprecedented. In total there were 145 missions over a span of about 12 years.

In order to increase performance, we also added three solid motors to the Thor and modified a launch pad at South VAFB to launch more and larger satellites for both military and scientific purposes. In addition, the Air Force began a new program called “Burner” which used the Thor to launch military weather satellites. All this worked out quite well.

But sometimes things were not so sweet and perfect. One day I was watching a Thor Agena launch from a hillside in South Vandenberg. The vehicle flew high into the sky and then suddenly there was a large explosion. The solid motors

separated from the core and were independently flying in a corkscrew like fashion all over the sky until they finally expended their propellant. The main vehicle descended into a VAFB forested area. A large reddish toxic cloud arose from the Agena propellants released at that site. Following this dramatic event my job was to lead the investigation into why this had happened. Once we gained access to the vehicle impact site, this mostly became a matter of recovering and inspecting the vehicle hardware. We learned that an engine turbine gear had failed due to a lack of lubrication. Once the gear failed the turbine then went far over speed and threw turbine blade steel all through the first stage causing the propellants to explode. The lack of lubrication was caused by a series of mistakes and hardware failures on the ground even before the launch. First the orinite lubrication additive container was incorrectly filled which in turn caused orinite to overflow and be trapped in the line going to the turbine. Orinite can freeze, and if it does, as it did in this abnormal overflow case, such freezing will obstruct the lubrication flow to the turbine. Normally the engine section is kept warm up to launch with ground air conditioning. However, on this day the air conditioning failed because a line in the air conditioner had broken and this had not been detected. Beyond this there was no accurate instrumentation to show that the engine section was below freezing temperature before liftoff. In this case it took a series of mistakes and malfunctions to cause the entire vehicle to fail. It took us a while to figure it all out but we did and of course after that we made changes to ensure it would never happen again. Fortunately, this was an exception to Thor's usual high flight reliability. This VAFB trip was extended and it was several weeks before I could return home to Canoga Park and again see Eileen and the children.

Overall, these were indeed good years and I spent a great deal of time at VAFB. VAFB was a very tolerable drive from the West San Fernando Valley where we lived and I drove there often in my Volkswagen (first the original 1958 and later a new 1965 model). In about 1970 there was a reorganization which increased my responsibilities to become chief engineer of the Air Force Thor activities. There was still a lot of work to be done even though most of these missions were being phased out by the end of 1972.

During the early 1960s Thor was also used for some important military work in the Pacific. One such project was "Fishbowl." This was at a time when atomic tests were still being done above ground and the purpose of Fishbowl was to improve knowledge of an atomic explosion in the upper regions of the atmosphere. The operational type Thor system was used for this testing which took place at a small remote Island in the mid Pacific called Johnston Island. The test shot was pretty

much the best trajectory to the selected altitude where detonation took place. There were five Thor launches in the Fishbowl test series.

I only visited Johnston Island once and the flight from Hawaii was interesting since we flew in a military cargo plane. I was a bit concerned since the ocean seemed without boundaries out there and the military people aboard were still talking about and looking for a similar aircraft that had gone missing in the same area the week before. Johnston Island was very small, at that time its' size was being increased with dredging operations. I think there were something like seven dredging machines in operation. They were from all over the world and operated by some pretty tough looking people that probably knew no other life. We were clearly told not to get involved with any of this- and of course we did not. During one of the launch operations there was an accident in which the Thor exploded and burned on the launch pad. This was a matter of considerable concern since there was a nuclear payload involved. But fortunately, nothing else happened and the payload was safely and securely removed. However, a heavy instrumented titanium ball was recovered from the wreckage and someone brought it to our office area in the US as a souvenir. Along the way I somehow acquired it and it remained my office for years as an interest object. At some point I realized I should have it checked for potential radioactivity. When I finally did the test showed it was not radioactive, so that was a relief.

Another Program of that era was the "437 Program." This was the nation's first attempt to develop an operational anti-satellite capability and it was also tested at Johnston Island. This also used the Thor operational system with two missiles for operational mission reliability. The concept was to destroy the satellite with a nuclear detonation. Much of the new work involved tracking the target satellite and determining the precise launch time. As I recall there was only one test conducted that followed the operational timeline with an actual satellite and there was only a fly by and no nuclear detonation. I believe the system did remain in operational status on Johnston Island until about 1970. Soon after this, nuclear tests in the atmosphere were banned and no further testing, such as we conducted at Johnson Island, was allowed.



High Altitude Test Certificate, 1970

Chapter 10: Saturn /Apollo Program and the Saturn SIV-B Simulator 1965 - 1966 and Apollo into the 1970's

In 1960 Douglas received a contract award for the third stage of the Saturn launch vehicle with was the Apollo moon mission rocket. This stage was known as the SIV-B. Its propellants were hydrogen/oxygen. Its flight mission was quite complex as it had a first burn to place the manned Apollo module into the initial earth orbit and somewhat later it was fired a second time to send the manned module on its way to the moon.

The Douglas team assigned to this project was initially located in Santa Monica but later transferred to the new Huntington Beach facility which had been constructed specifically for this program. The Huntington Beach facility was dedicated in 1963 with Vice President Johnson attending.

There was a great deal of work in this project so a portion was later assigned to the team in Santa Monica. This portion was separate from the SIV-B stage and was called the 500ST simulator. This simulator was planned to accurately simulate the SIV-B stage as a part of the larger Saturn full launch vehicle simulator which was to be a laboratory set up in Huntsville. In 1965 I was assigned as the Electronics Branch chief for this project. Later as people and events changed, I was promoted to be Chief Design Engineer for the project. This turned out to be a very successful assignment for me and played a role in preparing me for later leadership assignments. During this 500 ST assignment I made a number of trips to the NASA facility at Huntsville and was able to meet some of the senior NASA Apollo and Saturn program leadership. This program essentially completed in the Santa Monica facility by early 1966 and I moved on to other things.

The design and production work for the SIV-B stage continued at Huntington Beach up through the Apollo lunar mission in 1969 and later the stage was converted to be the Skylab missions in the 1970s. While I did not play a large role in much of this I did enough so that it became a part of my DNA.

During this period the Huntington Beach facility was filled with boundless people and energy. Starting in 1965 the Air Force Manned Orbital Laboratory program was added to the hustle and bustle of activity.

Meanwhile, I was still working at Santa Monica but that also was soon to change.

Chapter 11: Electronics Department and Thor 520 1966 – 1969

In order to properly tell about the next several phases I need to describe the context and conditions in the 1966 to 1969 period. You may recall that the Douglas Missiles Division was formed in 1955. Missiles were new and space applications were in the future. By 1966 this had changed dramatically. By 1966 Douglas had added two new large space programs (Saturn SIV-B and MOL). The Division had been renamed the Missiles and Space Division and it now had operations at two locations (Santa Monica and Huntington Beach). The Division's size was in the thousands of people. Work at both locations was moving at a hectic pace. There were two engineering departments - one at each location. Within this structure there were two Electronics departments - one at each location. I was still working at Santa Monica location. In 1967 a merger took place between the Douglas and McDonnell corporations, but this had very little direct impact on us.

After the 500ST simulator project I was given a new position as Deputy Chief Engineer of Electronics at the Santa Monica location. I felt this was a great assignment. I liked my boss; the people were great and the work was fun. I looked forward to going to work every day. My boss (Dick Ward) was an older man. He was single and a Harvard graduate and he mentored me like a father. We had lunch together almost every day. He had a house on Mulholland Drive that had an expansive view of the entire San Fernando Valley. Several of us would sometimes go to his house after work to talk and sing songs. Dick would play the piano. It was on the way home for me so that worked out fine. The electronics engineers were all very good friends both at work and play. As I said, "Work was fun." To a degree it reminded me of the college fraternity. Some of us even did a Barbershop Quartet at the annual Christmas party.

Most of our work was to design electronics for the Delta, Thor and Spartan missiles and space vehicles and we did it very well. But I suppose this was too good to last for long.

One weekend in 1968 Eileen and I and the kids were visiting some friends in Orange County. We were sitting by the pool at Ken Francis' house when his phone rang. It was Dick Ward and he wanted to talk to me. Dick told me that a Thor launch had failed and that he needed me to return and lead the investigation. Of course, we then packed our things, thanked our hosts and left as soon as possible for home. I soon learned that we had lost a Nimbus weather satellite with the flight failure of Thor 520.

The launch of Thor 520 was from VAFB and I drove there the next day. The flight telemetry data was immediately available, and it was very easy to determine that something had gone wrong in one of the gyro channels. In this case it was also pretty straight forward to determine that the gyro response was shifted 90 degrees from what it should have been. With this data and a couple of other facts the most likely cause was pretty apparent. Procedures, work orders and interviews showed that this gyro had been removed and reinstalled during testing a few days before the launch. This is a very simple four bolt operation (one in each corner of the symmetrical gyro mounting flange). The correct rotational orientation of the gyro was controlled with a steel index pin. But on examining an identical gyro we found that this pin was installed in the flange with a tight fit into a through hole. If the gyro was rotated 90 degrees from the correct orientation it was still easy to torque it down with the four bolts and the pin simply pushed back into the hole with no visual indication. The design should have used a blind hole for the pin that would not allow any further axial movement. Other improvements in markings and installation instructions would have also helped. To complete the investigation, we completed some simulations to prove the 90-degree gyro rotation caused the vehicle to do what it did and that was about it.

This was about the easiest flight failure investigation I have ever conducted. The leadership was very pleased to have the answer so quickly (less than a week) and they gave me more credit than I probably deserved but still that was a good thing in my mind. I had a little more work to complete a formal report with findings and recommendations but that again was pretty easy and then I was done.

Completion of this relatively simple task began to develop my reputation as a good leader of flight failure investigations. Flight failures cause great difficulty and stress in an organization and someone that can find answers and a path forward receives much credit. I found myself in this situation numerous times in future years. The failure of Delta 73 in 1969 was a good example of this.

Chapter 12: MOL Program Cancellation and Delta 73 Failure 1969

The Air Force Manned Orbiting Laboratory (MOL) was planned for manned reconnaissance from earth orbit. Douglas received the prime contract in 1965. The project was located at the Huntington Beach facility and it employed a large number of people. It would be very expensive. In the late 1960s rapid progress was being made developing unmanned satellites that could perform the same mission as planned for the MOL. As a result, in mid-1969 the government decided to cancel the MOL program.

The MOL cancellation notice to Douglas was abrupt and totally unexpected. The Missiles and Space Division had to take immediate action regarding employee layoffs and reassignments. A decision was made to immediately layoff half the people assigned to MOL and reassign the other half to other programs and then concurrently lay off an equivalent number of people presently working on those programs. Working this out was a huge effort that required close coordination between the Huntington Beach and Santa Monica organizations.

Within engineering most of the employee layoff decisions were to be worked out and decided within the technology organizations (Electronics, Structures, Mechanical, Propulsion etc.). In the Electronics department the leadership decided I should lead the working group selected to accomplish this massive undertaking. I don't know why I was selected but probably because I was at about the right management level, knew most of the people, was respected by most of the people and likely to be unbiased. No one told me these reasons but thinking about this later and now I am pretty sure this is correct. In any case this is what happened. The next Saturday Dick Ward and I, plus several others from Santa Monica, drove down to Huntington Beach and met with an equal number from the Huntington Beach Electronics team. I facilitated this meeting as best I could, and we worked all through the day and well into the evening making name by name decisions (layoff or retain/transfer for each one). This was extremely difficult and full of stress for all of us, but we finally got the job done. Personally, I did not have any training for this but as I went through that day, I naturally found a path to follow. This was only one day, and I was about to find there would be much more uncharted territory ahead for me before the end of 1969.

Following that Saturday meeting Dick and I returned to Santa Monica to implement our portion of the layoff and transfer plan as well as continue our other

normal design responsibilities. But only a few days later I learned that a new organization was announced. There would now be only one engineering department and one Electronics organization in the Division. Dick Ward would be the leader and Jack Shields (previous head of the Huntington Beach Electronics) would be his deputy. This made sense to me, but it also meant that I no longer had a job. Dick told me not to be concerned and that all would come out ok. But how could I not be concerned? I now had a wife and two children. I was not on the layoff list but still, I did not have an assignment and was basically just walking the halls. This was a very tough time for me but fortunately it did not last long.

One day in late August I learned that the Delta 73 launch had failed, and an Intelsat satellite had been lost. I quickly checked and found that this was not likely caused by the electronics system but rather something had gone wrong in the hydraulics system. At least that was a relief for me or so I thought at that moment. Right after that I received a call from Dick Ward telling me that the Vice President of Engineering (Pete Drummond) wanted to see me immediately. I wondered what this could possibly be about and headed off to Pete's office to find out. Pete said that he wanted me to lead the investigation into the Delta failure. I think I said: Ok, but why me, the failure was not electronic. Pete responded that's right, but I still need you to organize and lead this investigation and that he would make sure that all the necessary hydraulic engineers were assigned to help me. He further added this would include Fred Wright. Fred (Freddy) was an older more senior engineer and the most experienced hydraulic systems engineer in the organization.

So, with that I knew that at least I was not just wandering the halls anymore. But still I knew so little about the Delta hydraulic system. Freddy said he would help solve that and he certainly did. I then set about developing a plan for how the investigation should proceed. We were now up to the Labor Day holiday which would be three days off for the engineers and basically a gap in my plan. But Freddy said that's ok and that he could use the time to teach me about the hydraulic system. So that is what we did. Freddy and I worked together all three days of that holiday period. He taught me, taught me and then taught me again. At the end of this I felt I had a good understanding and at least knew the hydraulic system language. This paid off well the following day. That day there was a phone call conference with the NASA Delta program Director, Bill Schindler. Bill was a very energetic no-nonsense entrepreneur type of guy and that suited me fine. I had met him before during an investigation into the earlier Delta 59 failure. That failure had an electronic cause and so Bill knew me as what he called a "sparky" - his term for electronics engineer. During this phone conference briefing I described what we knew and didn't know from the flight data followed by my plan

for the investigation. I used all the knowledge and hydraulics lingo that Freddy had taught me. Bill said he was positively impressed and very satisfied with the plan. I have to say I felt good about my briefing that day also. —So far all was going well.

In the following days we set up a hardware simulation of the flight hydraulic system. And then we got lucky and were able to recreate the flight failure. The simulator data looked almost exactly like the actual flight. We found the cause was an unstable high-pressure relief valve which resonated with the steel hydraulic lines to the point that one broke and high-pressure hydraulic fluid sprayed all over the place. With such an occurrence there would be no further engine position control and the flight would be over. Finding out why the valve was unstable was more difficult. When looking into this we found that two engineers had been struggling with this same issue at the supplier and at acceptance testing. This should have been a red flag way before the Delta 73 flight. Their supervisor was aware of the problem but chose not to tell anyone else. This was certainly not good, and it led to process improvements for the future. Eventually we figured out that a very small damper sleeve in the valve was very slightly dimensionally incorrect. Sometimes like in this case it doesn't take much to take the rocket down.

When we finished the investigation and it was time to brief the NASA Review Board, I decided that Freddy should do the briefing since I felt he had the best technical knowledge and we were briefing a NASA board of experts. Freddy agreed. However, while Freddy knew this material very well, he was not very good at briefing it. During the NASA Board meeting the NASA experts came on very strong to the point that Bill Schindler became concerned that the end result would not be good. At the lunch break he told me of his concern in no uncertain terms and with direction to find a way to fix it. This actually frightened me. The only thing I could think of on short notice was to take over the briefing from Freddy and do my best and hope that would be good enough. So, with a little prayer that is what I did. I briefed it as simply and straight forward as I could. I called on my best possible speaking abilities and stopped worrying that I didn't know the next level of detail where their questions most likely would be. It worked. The experts settled down, listened to the relatively straightforward story I was telling them and decided not to try to drive me to that next level of detail. On reflection I realized I had displayed simple honest credibility and they bought it. When it was over the NASA Board was satisfied, Bill Schindler was happy, and I was on a high. From there we were able to complete our report, the fixes were made, and Delta was able to successfully fly again. Only later did I realize how

significant that day had been to my future. But after I completed the report I was once again back walking the halls and wondering what the future held. I was soon to find out.

Chapter 13: Thor/Delta Engineering Reorganization - plus the New Life in OC 1969-1979

In about November 1969, in the aftermath of the MOL cancellation, it was decided that the Thor and Delta engineering organizations would be combined. This made a lot of sense as the work was very similar. At this time, I was still wandering the halls and one day Pete Drummond called requesting to talk with me. Pete said he wanted me to lead this new combined engineering organization. While I had not expected this, I was not particularly surprised. I knew both the work and the people well. I had also worked very successfully with both Air Force and NASA customers. As I think about this now, I can see why the leadership selected me. At the time I had just turned 36 and I felt a little unsure about taking on such a large responsibility but given the circumstances I agreed to the assignment in a moment. There were several hundred people in this new organization so this was a very big deal.

Because of the MOL cancellation our work was being transferred to Huntington Beach. There was no reasonable way to commute several hours each way from our Canoga Park home and we needed to move to Orange County ASAP. Eileen and I had been thinking about getting a new house for a while so this was okay, but the rapid timing now required was somewhat of a shock.

The next Saturday Eileen and I left the kids with Eileen's brother and headed for Orange County to search for a new home. Initially we looked in the Orange/Tustin region where some of our friends lived. The weather there was pretty warm and very smoggy. We didn't find anything we liked. So, by mid-afternoon we headed toward the ocean on MacArthur Boulevard. When we reached Ford Road in Newport Beach the ocean breeze cleared the air and low and behold there was a planned new housing community called "Harbor View Homes" right there in front of us. We soon found a four-bedroom house model that we liked. We selected one across from the park and immediately signed the purchase contract. We were very happy, had a hamburger at Coco's and headed back to pick up the kids and return home.

We now had a path for the personal part of this transition. We moved into our new home just before Christmas 1969. Yes, 1969 was certainly a year to remember and for us it ended well.

At work I had the challenge of leading this new large engineering organization. No one told me much of what to do but I was thankful for my mentors who were there to help when I needed it. I knew at the outset the main criteria were to keep this running smoothly while meeting the Customers' requirements which meant cost, schedule and technical performance. I also was pretty sure this would be most difficult on the NASA side since it was much more dynamic and thereby placing more demands on engineering. I was right about this.

With these thoughts in mind I started applying most of my time to our engineering work on the NASA Delta launch vehicle. I became concerned about the working relationship between my engineers and the Delta program office which was not as good as it needed to be. To me it looked like the root cause of this was a ragged relationship with the Delta program office of systems development lead by Larry Gale. Larry knew what was needed from the engineers but his approach to them was often somewhat too harsh and dogmatic for them to enthusiastically accept. I am sure part of it was also on the engineer's side. So, what should I do? For sure I needed to know Larry better. I found that he always came to work early and started with a cup of coffee in the office kitchen. I decided to join him in this and during that we began discussing the latest news and challenges the program faced. This usually turned to what he needed the engineers to do. I was of course sympathetic and listened carefully usually offering to do what I could to help. As we continued, we also discussed family and friends and found we genuinely enjoyed our relationship. Over time this translated into a much better and trusting relationship with the entire engineering team. Technical work became better and more efficient and everyone was a winner. Another little part of this sometimes occurred in the late afternoon when Larry became hungry. He knew I always had a large container of nuts and so he often came by to get some and talk some more. This productive relationship lasted for many years.

After this, things progressed along well as the Delta workload continued for years to come. But before I go into that I will further describe life at home.

The Harbor View Homes community was a great place to live and raise our family. There was a large central park, community pool, close to elementary and high schools and good neighbors. The first year Eileen and I had a lot of work to do to get the house all complete and up and running. While Eileen was working on the furnishings, I took up the job of the outdoor hardscape and landscaping. At this point we had not yet been able to sell the Canoga Park house and the financial aspects of the new house were tough. In line with this I decided to do the hardscape and landscaping myself. We decided on used bricks since this would look good

and also be most adaptable to the incremental construction I envisioned. So, this was my home project throughout much of 1970. The design involved some grading/drainage, the front sidewalk and raised front entry area, front yard border, side walkway to the backyard and finally the rear patio which included a fire pit. All in all, I clearly recall there were 6000 bricks involved. Kevin was only five to six years old, but he was out there helping me move bricks from here to there which was good for both of us. As an additional note that hardscape still remains at that house to this day (that's 50 years). I still drive by there now and then to see if anything has changed and so far, it has not.

During the 1970's we also sometimes went to Mission Bay in San Diego. We took our power boat along and even put a sabot inside the powerboat when we trailered it to San Diego. Once the boats were in the water there was much family fun with water skiing, sailing and swimming. Sometimes we had an evening bonfire on the beach. We also still had the mountain cabin so there was always the question of where to go the next weekend or holiday. This finally became too much so we sold the cabin in 1977.

The 1970's and early 1980's were years of high inflation. To keep up with this Eileen and I took to real estate investments. We bought houses or condos, in San Diego, Newport Beach and Florida and rented them for a while and then sold for a profit. This required a number of high interest rate mortgages and had pretty high risk. This risk was not to our liking for the longer term but for the period we did this it was quite profitable. In the end we kept one of the best units in one of the best condominium buildings on Mission Bay which we still have and use today. It is directly on the beach and we like to watch people walking on the boardwalk and dogs running near the water's edge.

But now I need to leave these family memories and return to the very large challenges I faced on the Delta program.



Our new home in Newport Beach 1970



We pulled the boat about 90 miles to Mission Bay in San Diego during the summer



Sailing with Charlotte and Kevin on Mission Bay in San Diego



The view from our condo balcony in San Diego.



Enjoying a boat ride on Mission Bay, June 2018

Chapter 14: Delta Program 1960 to 1988 and PAM Program 1978-1984

The Delta Program Chief Engineer assignment was the most challenging I had faced thus far in my career. The Delta launch vehicle was a NASA program started in 1960 and contracted to Douglas. It used technology from both the Thor and Vanguard programs of the late 1950's. Over the following years it was employed to launch numerous communications, weather and scientific satellites in the 1960's and it had a reliability record of about 90% which was on par for that era. During most of the 1960's I worked on Delta from time to time usually for a failure investigation. By the end of 1969, I had been assigned to the position of Delta Chief Engineer, at a time when Delta had completed 74 launches. Because of the many different satellite missions there were a number of different Delta configurations. This kept the engineers very busy but also presented numerous opportunities for mistakes in both design and quality. Between 1971-1973 there were two Delta failures, Delta 86 and 96. Delta 96 failed in July 1973 followed by the failure of Delta 100 in January 1974 along with major anomalies on Delta 101 and 102. At this point NASA felt this program was living too close to the edge and stopped all launches pending a review. After the review NASA along with McDonnell Douglas management decided that both program leadership and mission assurance process changes were necessary.

The leadership changes were significant. Ted Smith, a highly respected MDAC VP from the Saturn program was assigned as the new Delta Program Manager. Leadership changes were also made in other Delta organizations such as Production and Quality. However, it was decided not to change the engineering leader (me). I am not quite sure why, but I think people like Pete Drummond and Jim Dorrenbacher voted in my favor. In addition, I had retained support from upper NASA management. Whatever the reason, I was still there. While I did not know Ted Smith very well at that time, he quickly took me in and treated me as one of his own. We molded a very close working relationship that lasted until he retired in 1982.

The mission assurance changes were also very significant. It was decided that NASA would have a Delta Launch Readiness Review Board chaired by Dr. Clark, Director of the Goddard Space Flight Center. This board was to review the readiness status prior to every launch and decide if the launch should proceed. It became my job to brief this NASA board on the launch readiness for each mission at what was known as the T-3 day review (three days prior to the planned launch

date). This became quite a task that required me to study and understand a large number of technical details, be personally convinced that the vehicle was ready for flight and then brief and be able to convince the NASA board that we had it right and were ready to launch. To help me accomplish this I changed some of my technical branch chiefs to best align with this new reality. They were outstanding engineers and together we formed a seamless team that understood the Delta vehicle very well and they were always in the front row when I presented the T-3 day launch readiness. They knew where I would reach my limit in response to a board member question and would immediately add further technical details as needed. I can very honestly say that as a team we did this job well and we were impressive. It was very hard work. One time I recall I was working a special added assignment as Red Team review leader for the Spacelab proposal in parallel with my Delta work. There was an upcoming Landsat launch at VAFB that I needed to brief the T-3 day readiness. I was so tired doing both of these things but I managed to get prepared and Larry Gale drove me up to VAFB while I slept in the back seat. The NASA board was satisfied, and the Delta Landsat mission was successful. In addition, our proposal won the Spacelab contract award. In the end all was well.

In addition, it was a good time when NASA decided that they would support Delta design changes that were focused on improving reliability. This was excellent and over time allowed the engineers to make the changes that they already knew were necessary.

So, with these changes the program moved forward once again and this time with a series of successful launches. While we still had an occasional launch failure the overall reliability was on a clear upward track. It took quite some time but eventually Delta became known worldwide as the most reliable launch vehicle.

In the mid 1970's communication satellites were a large part of the Delta business and they were growing in weight. In particular RCA developed a new three axis stabilized satellite that had twice the capability of previous spin stabilized satellites (24 vs 12 transponders). However, it was significantly heavier than the existing 2914 Delta could carry to orbit.

NASA was not willing to invest any more money to upgrade Delta in view of the future space shuttle. As a result, RCA and McDonnell Douglas struck a deal to upgrade Delta as a commercial venture. NASA agreed this upgraded vehicle could be added to the existing Delta production contract on a reimbursable basis as

long they were not involved in the non-recurring development. This became known as the Delta 3914 which was the first truly commercial space program. RCA made a fixed dollar investment for development and McDonnell Douglas added the rest and assumed responsibility for the total development cost. An additional development charge was added to each 3914 that was sold and RCA was to receive a refund of their initial investment after a specified number were sold.

The 3914 had new larger first stage solid motors and could carry 2100 pounds to geosynchronous transfer orbit compared to 1500 pounds for the 2914 Delta. This was a very big deal and my engineering team had the design/development responsibility. I assigned Alex Rossi to be the chief engineer for the project. Alex was a very good engineer and a fine gentleman.

The 3914 development moved along very well and the first launch was scheduled in December 1975. Alex and I were in Florida for the launch which of course was the first for the new RCA satellite. The day before the launch we were informed that Inspections had found significant debonded areas in the solid motors external insulation. This meant that the differential pressure of the ascent could possibly tear off the insulation resulting in overheating and total mission failure. Faced with this we decided that we must vent each significant debonded area and we had less than 24 hours to do this to maintain the scheduled launch. We developed a tool to make a small vent hole in each area to prevent the differential pressure and had the team of technicians and inspectors proceed with the effort. Alex and I decided we would stay on site to help with this however long it would take. This turned out to be almost all night but it was successful and all was ready to go the following day.

The launch was a resounding success much to my great relief. I recall a big hug with Jim Dorrenbacher after it was all over. This was all a great Christmas present and I returned home very happy. The new satellite was soon in orbit and providing new services. Had it been different very large technical and financial difficulties would have followed. As it actually turned out many 3914s were sold. RCA recovered their initial investment and McDonnell Douglas also did very well. And since this first commercial space venture worked out well it provided confidence to proceed with the PAM program that followed.

I continued as Chief Engineer until about 1978 when there was an organizational change. Ted became VP Space Transportation and I became Program Manager of the Delta and PAM programs. The Payload Assist Module (PAM) had become another important part of our launch vehicle business in the Space Shuttle era.

In the early 1970s it was National policy that the Space Shuttle would be developed to become the single dominate launch vehicle for both manned and unmanned launches. The Shuttle business model was flawed but in this early period the lower cost began to put a damper on Delta's future business. We looked for a means to transition into the Shuttle era while keeping Delta alive as long as possible. This gave birth to the Payload Assist Module (PAM) program which was funded by McDonnell Douglas as a commercial space program. Many satellites needed to be boosted to a higher orbit than that provided by the Space Shuttle. PAM was conceived to provide this additional boost and it could also fly as the third stage on Delta to complete the same objective. While customers were very happy with the Shuttle's lower cost, they were concerned that development delays would put their business plans at risk. We solved this with PAM which could fly on Delta if the Shuttle was delayed which turned out to be the case. It was great for us since we were then be able to sell more Deltas and have a good entry to use with the Shuttle later. This excellent strategy was developed and sold by Ted Smith and Larry Gale. My engineering team provided the technical support and we became very knowledgeable about integrating a payload into the Shuttle and this pathfinding work with NASA gave us a foothold for many years. In addition, PAM was used on many Deltas, extending its life until the Challenger accident in 1986 gave a new birth to Delta and other expendable launch vehicles.

In the late 1970s I was spending considerable time on PAM as program manager and I had an instrumental role in negotiating a contract with the Air Force to launch 28 GPS satellites. These were initially planned as Shuttle launches but after the Challenger accident, they were launched on Delta II in the 1990's. This all became a very important part of the Delta life story. However, in the early 1980's things were still going pretty well for the Shuttle PAM system. Two PAMs plus their satellites were the first Shuttle operational mission payload in 1982. That was a good day for our team as we watched national TV showing the spinning PAMs lifting up out of the Shuttle cargo bay. Our hard work since 1978 had paid off well. This hung together until early 1984 when things went sour with our first PAM failure. That was a very serious event which I will cover in a later chapters.



A T-3 day Delta launch readiness briefing in Florida, 1974.



PAM/Shuttle 1982.



From the Los Angeles Times article on Delta, around 1980.

Chapter 15: Japanese Space Program 1982-1984

In the late 1970s and early 1980s McDonnell Douglas was able to sell certain Delta technology and launch vehicle hardware to Japan to assist them in development of their N series launch vehicles. At that time this was a part of US national policy to assist Japan's space program. It was very good business for us since the Japanese were willing to pay a high premium price for both the hardware as well as the technology. It was the US policy that our sales should be at least one generation behind the latest technology that we were currently using on Deltas. This worked for a while but became more difficult when they started developing their N-II launch vehicle which used the latest inertial guidance system. Anyway, up until 1980 these sales had been managed by Dick (Jake) Jacobson as the senior McDonnell Douglas Astronautics (MDAC) executive. In 1980 Jake transferred to a new assignment in Huntsville leaving his previous assignment open. Low and behold, much to my surprise, the MDAC leadership asked me to accept a reassignment to Jake's previous position. Initially I was not sure about this. Jake was an ex-Air Force officer with a brassy personality. I knew I was not of this type, but it seemed that the leadership thought this was ok and probably even desired. After thinking it over a while I decided this should work out and I accepted. And of course, it also helped that this new assignment would be at the senior director level just below VP. Ted Smith was retiring and Adrian O'Neal, another well respected MDAC VP, was named to replace him. I would initially report to Ted and then later to Adrian and I was quite satisfied with that. I knew this would be a new learning adventure and I became quite excited about it.

Picking up where Jake left off, it seemed to me that this was going to be less demanding than my last assignment although there would most surely be more long-range travel involved. Almost immediately the Japanese Mitsubishi Corporation executives wanted me to visit them soon in Tokyo. Ted told me that he thought I should take Eileen along as it would be a nice trip for her. However, when the Japanese learned this, they sent a message that it was best if she did not come along. Of course, then she didn't go on this trip. When I got to Tokyo, I learned that these Mitsubishi executives do much of their work in clubs at night and they had of course planned this sort of activity for my visit. It is a male sort of thing in their culture, so I guess it was best that Eileen had stayed home. They were very social to me and they gave me a nice gift to take back to Eileen. Of course, we also talked some specific business and technical issues in their Tokyo offices. I found these meetings to usually be pretty easy and on the slow side as a

great deal of time was taken up with translations. But we managed to make our deals so that both sides were satisfied. On the financial side I was especially satisfied with the results. I made a number of these trips to Japan and the Japanese made several trips to visit us in Huntington Beach. On one of their visits Eileen and I had them as guests at our home in Newport Beach for dinner. They seemed to appreciate this as being something special. For the most part there was not as much technical content about this assignment but there was a great deal about relationship building. In this regard I was learning a lot.

I do have a very strong memory of one trip that I took out to the launch facility at Tanagashima. It was for the first launch of their N-II vehicle which used a Delta design fairing (vehicle structure surrounding the payload that separates in flight) purchased from MDAC, built in Huntington Beach and installed on the vehicle by the Mitsubishi personnel. I arrived somewhat late in the afternoon on the day of the scheduled launch. The ground level winds were high that day so the launch was scrubbed and rescheduled for the following day. The service tower had then been moved back around the vehicle.

As a matter of background, I need to explain some Delta history for an understanding of what happened next. The Delta fairing sits on a circumferential ring at the top of the second stage. It is loosely retained to this ring by six cleats that normally have about a 3-mil gap. Back on Delta 102 in early 1974 these cleats were incorrectly installed (too tight) and the fairing hung up during separation. After that, as Delta Chief Engineer, I usually went out to the vehicle and up the service tower to the base of the fairing where I then did a personal check of the fairing cleat installation by sliding a piece of paper between the cleats and the ring. Actually, I did this trip mostly to make a visual examination of the vehicle as I walked down each level of the service tower. Never once in the following years did I find anything wrong with the cleats.

This afternoon at Tanagashima, most of the people had left as they had been there since early in the day. One of the Japanese engineers had remained to act as my escort, and he asked if there was anything special that I wanted to see or do. I then thought of my old Delta habit and asked him if we could go out to the fairing level in the service tower. He said sure and we proceeded. When we got there, I decided to do my cleat inspection using a paper slip from my notebook. And oh, my goodness the paper would not slip under several of the cleats. I sat down for a while and wondered what I should do. I figured I had to say something about this so I told the engineer what I had found (i.e. tight cleats). He murmured a bit and then got on the phone to call his boss. Before long there was a hustle and bustle of

activity as the engineers decided the cleat installation needed to be redone. I left for my hotel and returned the next day for the launch. That Mitsubishi executives also came down from Tokyo for the launch. The word had spread that Mr. Ordahl had found a problem but it had been corrected and things were ready to go. They were completely mystified as to how a senior executive (me) could possibly find something wrong with the rocket. After the successful launch, later that day they had round after round of thanks, applause, hugs and bows directed to me. I returned the thanks. A little later I learned that the engineers had figured out that the cleats became tight on one side because of the previous days wind and that the fairing would have rather quickly worked loose with the vibration of launch. Nevertheless, the credit I received that day stayed in the minds of my Japanese hosts for the rest of my tenure in this assignment. I was lucky again.



Japanese launch vehicle, Tanegashima, Japan 1983.

Chapter 16: Purchasing the Seaview House

In 1977 Eileen and I began looking for a new house with a view in Newport Beach. We didn't need to look very far since new houses were being built on a hillside not more than a half mile or so from our then current home in Harbor View Homes. This new hillside area was a gate guarded community of about 167 houses called Seaview. We looked at the models and decided on one we liked, the single story three-bedroom, 2.5 bathroom model. We initially selected this model on a lot on the highest street in the development. We put a deposit on it but then started to have second thoughts about this lot. It had a nice view but the parking situation in front looked pretty tough especially since both kids were still living at home. After a couple of days thinking about this, we decided to turn it back and look for another lot in the next development phase. We found that lot on the next lower street. It was about half an acre with a wonderful view across all of OC and it also had better parking. We decided this was the right one even though the price had not yet been set. We asked the salesman when this property would be for sale. He could not tell us since the date had not yet been set and neither had the price. This was at a time of rapid house price escalation, so we were pretty sure it was likely to be considerably higher than the one we had just turned down. We didn't even know if we would be able to buy it as there was a lot of competition for the best lots such as this one. This was a considerable challenge, but we now had our hearts set on this house.

I was traveling a lot so our best chance was for Eileen to keep close watch as to when this property would come up for sale. We made out the deposit check and put it on a shelf to be immediately ready when needed. Then Eileen started calling the salesman every day before she left the house for shopping or other errands. She did this without fail for many weeks. By this time the salesman knew her very well and then one day he called her to tell her to stand by for a second call after a meeting they were about have related to releasing the property for sale. Sure enough he soon called again with news that this specific property was now for sale. She took the deposit check, quickly drove the short distance and bought the house. I suppose it was on the market for less than a half hour. We have never had any second thoughts about this purchase and we still live there today. We often tell ourselves how lucky we are to have done this when we did.



Our home in Seaview, Newport Beach



View from our Seaview house looking towards the San Gabriel Mountains



View from our Seaview house looking towards Fashion Island and the ocean

Chapter 17: Space Transportation Division and VP promotion 1984-1986

In early 1984 Adrian O'Neal was transferred to a new assignment and I was promoted to Vice President Space Transportation. This was great as it was something I felt I was heading toward for quite some time. In celebration, Eileen and I hosted a nice dinner with all the senior Missiles and Space Systems executives and their wives in the wine cellar of the Hyatt hotel in Newport Beach. Hosting a dinner for the senior executives was a Huntington Beach tradition whenever someone became a vice president. This was really a highlight in my career as I was now 49 years old and I can only say I was very happy to have come this far. But I know now that there was still much ahead.

I moved into the nice office previously occupied by Ted and then Adrian. The future looked bright but there was plenty of trouble coming just around the corner.

In the first week of February we had two PAM missions scheduled for a Shuttle flight. I decided I would go to Houston to be with my direct customer Hughes, the satellite customer Western Union, and the Indonesian government's representative. I arrived at the Johnson Space Center for the mission as planned and everything was going well but only up to a point. The Shuttle flew to orbit as planned and a short time later the Shuttle mission specialist released the spinning PAM and its Westar satellite from the cargo bay. This event was watched by many in the Nation on live TV or later on the evening news. The PAM /satellite continued in its orbit for 45 minutes to gain a safe separation from the Shuttle prior to motor ignition. At the scheduled moment the PAM solid propellant motor ignited. It burned for only about 14 seconds and then the nozzle blew off. This mission had failed this instant and we were left with the satellite and residual PAM pieces in a useless orbit. And to make things worse there was no telemetry on the PAM to give any insight into what had gone wrong and further we still had another PAM in the Shuttle cargo bay. We would have to decide very soon whether or not to launch that second PAM with its Indonesian Palapa satellite.

I was in a horrible situation. I was the focal point for the decision of what we should do. Initially I coordinated with NASA to see how much time we had. They said they would adjust the Shuttle flight to give us an extra day. This meant we had about two days to decide. I next called Gerry Johnston, VP of Engineering at Huntington Beach, asking him to become engaged and have people study the production and quality records for these two Thiokol motors, and when that had

been completed to help me with the decision we had to make. Following that I called Ed Garrison, the CEO at Thiokol (motor supplier), and asked him to do the same. From there on I could only hope that someone would find some new data that would help inform this next launch decision. Time wore on but no such additional data was found.

NASA did not want to land the Shuttle with the remaining cargo aboard for safety reasons even though all had been designed for that possibility. This meant there was a decision bias already on the table. There was a lot of risk here with no clear way to quantify it in this short time. I thought that given our previous history of success with this motor we most likely had sustained some undiscovered damage to the Westar PAM motor. But this was only a guess. When time ran out the only data we had was that the motor met all the quality requirements.

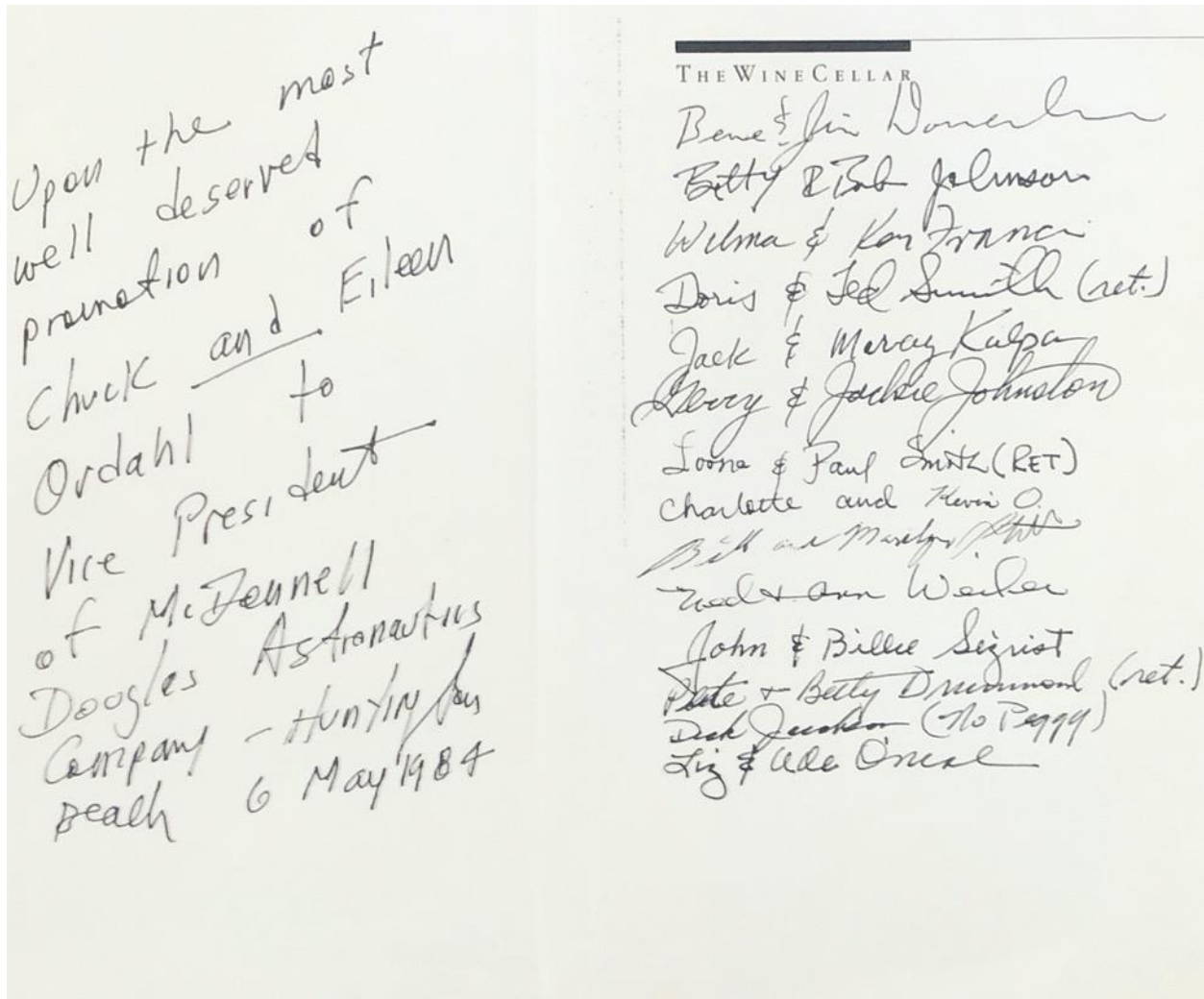
So, at that point after concurrence from Gerry Johnston and Ed Garrison I recommended to my customer that they proceed with the mission. We had a meeting for all to concur in this final decision and with that the team proceeded to implement the launch at the next appropriate time. From there on everything proceeded like the first launch all the way to and including a motor failure at almost the same time after ignition. We had done all we could, but the outcome was terrible. I had previously made many launch decisions but never with a result anything like this.

But my work was not yet done for this day. Within the hour I was requested to attend a news conference to help explain what had happened to the reporters preparing for the next TV news release. The news conference was attended by me along with Dick Brandes from Hughes and Glenn Lunny from NASA. The conference was very factual and not difficult when compared to the earlier part of the day. On the way home the following day I wrote a memo to record what had happened the previous days especially the decision process details.

Of course, there was an investigation to find the technical cause of the two motor failures. That was very difficult and took months to complete and even then, we were unable to find the true root cause. The nozzles composite material construction had been weakened by what became known as density variations that could not be detected in x-rays. Since we were not able to find the cause of the density variations, we abandoned the 3-D carbon-carbon composite construction and reverted to an earlier but heavier carbon phenolic design. At this point we had a substantial line of delayed missions and unhappy customers. We used CT-scan inspection to screen and use a few of the already built motors but there still was

more risk than anyone wanted to assume for very long. Thiokol refused to make any more 3D C-C motors because they could not figure out how to make them more reliable. All new motors had to use the heavier nozzle design. In order to provide for this additional weight, I had to get NASA to take the Shuttle to a higher orbit for our missions. They agreed to do this but only for an added cost. But I was thankful that at least we were able to eventually fly the missions we had been contracted for.

We continued to fly PAM missions on the Shuttle until the Challenger accident in 1986 caused a national policy change to move all unmanned satellite missions back to expendable launch vehicles such as Delta. These were indeed very dynamic times in the space transportation business and I enjoyed being in the middle of it.



Attendees at our promotion dinner, May 1984.

Chapter 18: Delta 180 Project (Code Name: Vector Sum)

I need to explain the situation I faced as VP Space Transportation in 1985. The Delta was no longer in production and there were only a very few remaining launches scheduled. There was some remaining Delta hardware but without any assigned missions. The PAM program was still in a recovery mode from the failures of the previous year. We had recently received a contract for a new Titan five-meter fairing but that was relatively small in dollar amount and employment terms. The Delta engineering team and much of the PAM engineering team would soon exhaust their remaining work. I felt that this wonderful engineering team that I had helped develop over the previous 20-25 years might soon have to be disbanded. Basically, my team was on the ropes. I was hoping it was a “down but not out” situation but I surely didn’t know what our next effective move could be. The situation was dire.

One day in February 1985 I was in my office thinking about this situation and I even said a silent prayer to help me find my way. And I have to say there was soon to be an answer to that prayer. Shortly thereafter I received a call from Dr. Mike Griffen, who was then a systems engineer at the Applied Physics Laboratory (APL) working for Lt. General James Abrahamson, Director of the recently formed Strategic Defense Initiative Office (SDIO). Dr. Griffen told me that he was working on a project that could potentially use some of the remaining unassigned Delta hardware but for security reasons he could not tell me much more. He asked me if I would send a Delta systems engineer to Washington to help them further develop the feasibility of this plan. Of course, I said I would and immediately asked Jack Ganoung, of the Delta engineering team, to get a flight to D.C. ASAP. Jack was well received at the SDIO and returned shortly with a 30-day contract to have our engineers help flesh out the plan. The plan called for a space intercept of a thrusting missile by another missile configured as an interceptor. This could be accomplished with Delta hardware and the Delta Engineers had very good ideas on how to get it done. This was exciting news for all concerned, including me. SDIO almost immediately extended our contract and we were underway. The technical requirements were straight forward and the contractual requirement was to get the job done in 18 months or less at a cost of about \$150 million. I was sure the Delta team could do this well. The project was called Delta 180 with a sometimes used code name of “Vector Sum”.

President Reagan had a special interest in this project since he viewed it as an early demonstration of his strategic plan for a defense against ballistic missiles. This

was truly an answer to my prayer. We now had plenty of work for the entire team through at the next 18 months.

This project was very ambitious as it was to be a very large on orbit experiment like nothing done before. It required the cooperation of the Air Force, Navy and NASA along with SDIO and the industry team. There were many skeptics. Lieutenant General (LTG) Abrahamson (Abe) was having some difficulty with these supporting organizations as their leaders feared a failure would reflect badly on them. At one point LTG Abrahamson called a meeting with them to garner more support and enthusiasm for the project. He asked me to attend. At some point in this meeting LTG Abrahamson asked me: "Chuck - Can the McDonnell Douglas Delta team do this mission"? I had previously worked with Abe during our PAM and Shuttle days when he was at NASA. He knew what my answer would be. I said: "Sir, The Delta engineering team has been working their whole careers getting ready to do this mission for you and SDIO". He said: "Good, and I am sure we all will join". That is all it took and the whole government /industry team was off and running. Of course, I returned to California very happy and pleased. This was in stark contrast to my mood when returning from Houston after the PAM failures the year before. The team went on to meet all requirements (technical, cost & schedule) when the mission was completed in September 1986. President Reagan used the results in his negotiations with Mikhail Gorbachev later in 1986 at Reykjavik about nuclear disarmament and the need for defensive systems. Delta 180 helped further convince President Reagan he was right to not back down on his vision for SDI.

In order to be sure to get this right I will quote from SDI records about this mission: "The Delta 180 program was spawned by a rare combination of circumstances: a national strategic need, the new forward looking SDIO, available funding, adaptable hardware and most importantly an innovative group of people in government, industry and academia that became the Delta 180 team."

And to further top it off SDIO went on to request the Delta team accomplish several additional space missions over the next few years. These set new standards for effective and efficient orbital experiment missions.

As I recall and write about this period of my career, I actually get goose bumps (if that is the right term). I had not expected this much when I said that little prayer back in early 1985. But I will say thanks once again.



DELTA 180

*In the midst of a crisis
the rocket was launched.
As it ascended and pulsed
and passed out of view
the hope of the space program
was rekindled anew.*

*Out of the ashes of its
most recent disaster,
riding the shock waves
on the wings of a Phoenix;
Under the guidance of
preferential players
it peeled off its boosters
and stages in layers.*

*A dedicated dream that
was vibrant and new,
the rocket left earth on
a course that was true,
encompassing a vision known
to only a few,
in a symbol of friendship
and teamwork that grew.*

*The spirit and soul of the
stouthearted crew
watched from the ground as
it faded and flew,
true to its mark.*

*It veered straight ahead,
its vectors the sum
of a dream that was born
and rose to the sun.*

*In this storybook launch
the dream had been won.*

Maria Rendine

Delta 180 launch, 1986

Chapter 19: Huntington Beach Engineering and Operations Division and Delta 178 Failure

1986 was a tumultuous year. The Shuttle Challenger was destroyed in an accident and the entire crew of seven died. National policy was changed to no longer use the Shuttle for unmanned type payloads. This meant that the PAM as previously operated from the Shuttle was dead. The Delta 180 program was going strong however in May, Delta 178 failed putting a cloud over the Delta 180 mission scheduled for later in the year. In the middle of this, the position of VP Engineering and Operations (E&O) became vacant.

Jim Dorrenbacher called and asked me to assume this position of VP E&O. He said it would help broaden my experience on the operation side of our business. The operations side included: manufacturing, tooling and facilities. This was all good but also meant I would have less time to spend on Delta and the PAM program transition. I accepted this new position but still spent a considerable amount of time on Delta primarily due the failure of Delta 178.

Delta 178 was carrying the GOES-G weather satellite and of course this satellite was lost. The vehicle flew for only about 60 seconds when there was an abrupt main engine cutoff followed by loss of control, structural breakup and command destruct. I led the investigation and the redesigns required for a return to flight in time for the Delta 180 mission. After the failure, I immediately traveled to the launch site in Florida to start the investigation. The first stage wreckage had fallen into the ocean, but the depth was relatively shallow. We were able to recover the engine section and this along with the telemetry records helped move the investigation along. It was apparent that the engine cutoff was caused by an electrical short circuit but where and why that happened was unclear.

With the pressure of schedule there were many, including NASA, that wanted to simply add more tape protection to the suspect tunnel wiring and move on. I was skeptical of this simple and uncertain corrective action, but I felt I was bucking the crowd. Still everything in my head kept yelling that we needed to do something more that would conclusively prevent another failure from whatever caused this one. I concluded that since we didn't know the cause we needed to add a redundant circuit to make sure a single short would not cause a similar engine cutoff. But since this was more complex there was a lot of resistance to this approach. Nevertheless, I just could not budge from what we knew was the safest way to go. Finally, I went to Jim Dorrenbacher, the Huntington Beach Site General

Manager for help. He agreed with my recommended plan and then called the NASA Goddard Space Center Director and told him that we would not agree to fly Delta again unless this redundancy change was made. With that the change was authorized and implemented and I was much relieved. Delta 179 flew successfully clearing the way for the very important Delta 180 mission in September. As a postscript it turned out that the short circuit did reappear in later flights, but the redundant circuit prevented an engine cutoff and thereby no impact to the flight. Much later it was discovered that unexpectedly high aerodynamic loading was damaging the first stage tunnel covers causing the short circuit. Once that was discovered, the tunnel covers were strengthened providing a full and complete corrective action for the Delta 178 failure cause.

Once the Delta redundant circuit change was authorized, I was happy and ready to spend more time on my Engineering and Operations assignment. I held that position for only about a year and much of that was spent on facilities issues. During this period, it was decided that we would build a new five story office building at Huntington Beach for some new Space Station work we were expecting and a new production facility in Colorado for the Delta second stage. After the Challenger accident and the PAM demise the Air Force had decided to authorize additional Delta production in the form of Delta II.

Much of the Facility Group's work in this period was to get the designs and approvals of these new facilities completed. I find it interesting to note how different this process was between California and Colorado. In California it seemed that they didn't welcome this new facility while Colorado called for us to please come and complete the new facility as soon as possible. In California we had to meet all sorts of regulations and it took eighteen months to get the design approved while in Colorado the whole thing was completed in less than about six months.

Another event during my tenure in this assignment was a strike called by the production workers union. This was something I was totally unprepared for but fortunately others were able to implement the contingency plans and complete the successful negotiations. There was little actual disruption to our production and we even were able to conduct a successful Delta launch at VAFB during this period. I have to say I mostly watched and learned.

During this period the Huntington Beach organization was also experimenting with a new team self-management concept. The idea was that teams with the same goal could manage themselves with little or no direction from above. We had such a

team comprised of the program and functional organizations at the MDAC HB Missiles and Space Company. I ended up being selected as the facilitator of this group and I found this to be very tough - but I suppose it was a worthwhile learning experience. This brings to mind Bonnie Soodik. About this time Bonnie transferred to Huntington Beach to lead our Quality Systems organization. She brought in a lot of excellent ideas and was the first woman Vice President in the Huntington Beach organization. I enjoyed working with her and we helped each other through some difficult situations. For me this often occurred in these management working group sessions. Being senior I guess I was mentoring her however as far as I was concerned, she helped me just as much.

And before long Space Station was calling so I would soon be moving on again to a new and exciting program.

But before I leave 1986, I need to relate an additional important development. Eileen and I missed our first mountain cabin which we had sold in 1977. Since we now felt the SeaView house was fully settled in we were ready to look for another second home in the San Bernardino Mountains. This time we decided to look for a place at Lake Arrowhead since it offered both recreation and beauty in an Alpine setting. We spent a number of weekends looking and then found the right place. It was on a very accessible street, built on the hillside and with a beautiful view of the lake and the mountains beyond. It was 2154 square foot size with four bedrooms and two bathrooms. We made an offer and it was accepted within a couple of days. Subsequently we purchased a dock on the lake and a near new 22 foot Cobalt power boat. We remodeled this house in 2018 and go there as often as possible.



Looking at Lake Arrowhead from our deck, 2019



One of my favorite pastimes is fishing at Lake Arrowhead



Fishing from the boat



My happy place, on the dock at Lake Arrowhead, 2020

Chapter 20: Delta II Program 1987 – 2018

Delta II began in 1987 and its last mission was in 2018.

As previously mentioned, the PAM program died with the change in National space policy after the Shuttle Challenger accident in 1986. Our previous contract called for launch of the initial 28 Global Positioning Satellites with PAM from the Shuttle. Now the Air Force decided that their best course was to restart the NASA Delta program and renamed it Delta II. So out of ruins of the Challenger disaster this good news arose.

These GPS satellites required more launch vehicle capability, so redesigns were necessary for this new Delta II. This was fine with us since now many of the Delta engineers could move from the Delta 180 project to this new Delta II project. The first Delta II was successfully launched in early 1989. Delta II was used not only for the Air Force missions but also for important commercial communications satellite launches and various NASA scientific missions in the 1990s and beyond. It was very good business for the Huntington Beach organization.

During much of the Delta II era I was assigned to Space Station or senior executive duties however Delta II was one of our most important programs and I watched it closely. I was occasionally called upon to help out during some specific difficulty and as always, I have been happy and willing to work on anything that was necessary no matter what or where that might be.

There was a unique contract clause in the Air Force Delta II contract that drew considerable attention in the senior executive offices. The clause called for a significant bonus if the full series of 28 GPS satellites were successfully launched with no failures. The team worked their way through the first 25 GPS launches and all were successful. At this point the executive leadership sat down and discussed what it would mean financially if one of the last three in the series should fail. It was significant so we decided that it would be wise to insure these remaining three launches for the value of the string bonus. The Air Force was consulted and they agreed that while unusual this would be alright with them. So, we went ahead and insured those three for a premium of about 10% of the bonus. All three launches were successful but we still felt the insurance was worth the cost. It is interesting to note that the next Delta II launch after those three did fail (Delta 241 in 1997).

I also played a role on Delta II for two failure investigations. These were for the failures of Delta 228 (Koreasat) in 1995 and Delta 241 (GPS IIR-1) in 1997. The

Koreasat failure had its roots in the design work done to upgrade from Delta to Delta II. The structural changes in the region of the solid motor attachment covers were inadequate for flight conditions that were encountered. A protective cover fractured and the resulting thermal conditions caused a dud of the explosive lines used for solid motor separation. One solid motor failed to separate from the core and that was enough to fail this mission. The corrective actions included a full redesign and requalification of this critical area as well as adding redundant thermal protection to the explosive lines. A safe and complete recovery from the Delta 228 failure was an imperative for the future Air Force GPS missions. The launch schedule was very full in this period.

The Delta 241 failure at Cape Canaveral, Florida in 1997 was the most serious and dangerous event in the Delta launch history. This vehicle was less than 2000 feet in altitude and still almost directly over the launch pad when one of the solid motors exploded. This in turn caused the entire vehicle to explode over the launch pad and blockhouse. Burning debris came down all over the area. There were no injuries but the people in the blockhouse could not leave for several hours. During this period toxic gases started seeping into the blockhouse where this launch crew was confined. Fortunately, they were able to use the emergency breathing equipment during this frightening time. When I arrived the following day, the whole area looked like a war zone. Most of the cars in the parking lot were all burned out. We were only allowed to walk on cleared and very controlled pathways since there were still many unexpended explosive components in the area.

The failure investigation was led by the Air Force (Col. Heckel) and I led the industry team supporting him. The investigation was very difficult and slow going which is often the case when a solid motor explodes. We were never able to find the explicit root cause. It was either due to a faulty water draining procedure at ATK (motor supplier) after the case proof test or possibly some undetected motor handling damage. There was an extensive review of the motor manufacturing processes which resulted in numerous improvements for future production. Extensive ultra-sonic motor case inspection procedures were introduced, and the proof test facility and procedures were corrected. It was one of those situations where you do all you possibly can for corrective actions but are still not sure you have done enough. In any case there were no other solid motor failures in the remainder of the Delta II's history and other programs such as GMD benefited from the improvements that were implemented as a result of Delta 241.

As a historical note the blockhouse involved in this 1997 event was the same blockhouse, I had climbed up on to watch that Redstone missile launch back in 1956. Delta 241 was the last use of this blockhouse and for safety reasons all future launches used a new remote facility. At the completion of my Delta 241 work in Florida I was happy to return to Southern California much the same as I was after working there on Thor 101 in 1956.

Historically Delta II and its role in launching the first GPS constellation of 28 satellites was very important to all Americans. Today almost everyone uses GPS in their smart phones for many daily activities. I often feel proud to have played a role in this important technology that has provided so many benefits to so many people.



Delta 241 Explosion

Chapter 21: Space Station Program 1987-1992

For many years a Space Station contract had been the goal for the Huntington Beach MDAC team. This team had accomplished many advanced space studies leading toward this goal. By 1987 NASA had issued the final request for proposal (RFP) for the Space Station Freedom. NASA had decided to divide up the design and production into four work packages. We decided to bid on work package 2 which had the largest amount of hardware and integration content.

Sometime in 1987 Jim Dorrenbacher asked me to join the Space Station organization as deputy program manager. He had previously hired Bob Thompson to be the program manager. Bob had previously been with NASA at the Johnson Space Center and had been a key member for both the Apollo and Shuttle programs. As such he was very well known and respected by NASA- especially in the human space area. However, the deputy position was still unfilled, and we still needed to fill it with someone qualified and known to NASA. It turned out that my name came up. I had not worked very much in the manned space area, but I had a good reputation with NASA Goddard and at NASA headquarters from my work on Delta and PAM. Anyway, I seemed right for both the proposal and the work beyond. I really didn't prefer this assignment feeling I would be more like a fifth wheel but I knew I was needed so of course I agreed. I joined this team pretty much in the middle of the proposal effort.

We had an excellent design team and they put together a very good technical solution in response to the RFP. The schedule to accomplish the program was credible and met the RFP requirements. The remaining part of the winning strategy was to provide what we termed "lowest credible cost." I felt that sometimes we were too close to the edge or over the edge on the credibility part of these estimates. This came mostly from my experience with the design work we did to integrate PAM into the Shuttle. In that case we had woefully underestimated the cost. But nonetheless I did my best to help with the cost estimates. We pretty much convinced ourselves that this was a cost reimbursable award fee contract in which change orders would likely be adequate to restore the necessary level of contract funding. That assumption turned out to be wrong.

Once the proposal was submitted, we prepared for the oral exam which was mostly briefings followed with questioning by the NASA proposal evaluators. The exam was held at the Johnson Space Center. I was pretty worried going into this as I felt I was on unfamiliar ground, but I handled my part much as I had done that day

back in 1969 when I took over the Delta 73 briefing from Freddy. It all turned out okay.

The proposal strategy worked, and we won the work package 2 contract. When this occurred, there was of course great celebration across the entire Huntington Beach Space Systems organization. The long-held goal had been achieved.

It should be noted that the work package partitioning of the space station was a flawed approach from the beginning. Each work package was managed by a different NASA Center and this immediately set off a competition for funds between them as well as a considerable amount of technical disagreements along the way. As a contractor it was very hard to work to a plan in this environment let alone meet the low cost we had proposed. It is hard to believe that the great NASA that was able to land men on the moon in 1969 could not find a way to properly manage the space station in the 1980's. Anyway, in the next several years we found our team heading down a very difficult path that was not going to end well.

Thinking back, I don't see much we could have done different or better in those circumstances. We were caught up in things well beyond our control. Eventually this led to congressional hearings into why the large space station cost overruns had occurred. For those of us involved the answer was pretty obvious - a flawed organizational setup by NASA from the beginning.

To correct the situation the whole space station program was reorganized into a more traditional industry led prime and subcontractor arrangement. Boeing became the prime contractor and McDonnell Douglas took up a subcontractor role. While this was a disappointment for us it was really for the best as everyone finally began acting as if they were on the same team. The space station this team designed and built is the one orbiting above us with its' human crew to this day. Their experimental work continues to benefit all of us here on earth. I can only say it was great to have been a part of making it happen despite how difficult it was.

Chapter 22: Space Station "Keep it Sold" Activities and the Washington DC years 1987-1993

In the past McDonnell Douglas had learned hard lessons about the Washington D.C. political scene and how decisions made there could have devastating impacts on certain programs such as what occurred with the abrupt Skybolt and MOL program cancelations in the 1960's. It became company policy to have an assigned program executive spend time in DC to ensure we did all we could to prevent such a surprise again.

For the space station program this meant working in D.C. to help make sure it was approved and funded in each annual congressional appropriation cycle. Once again Jim Dorrenbacher asked me to take on a new and very different type of assignment. And again, I was not sure I had the right skills for this. But since I thought I was a bit of a fifth wheel in the project work at Huntington Beach, I felt this would be a good thing and was willing to give it a try. I was then fortunate to receive some help and guidance from Bob Johnson a very senior McDonnell Douglas executive who had just finished doing some similar work for the C-17 Aircraft Program. Bob provided some excellent ideas on places to live and eat as well as advice on the congressional visits.

This new assignment did not require a move to D.C. but rather weekly cross-country travel during the congressional appropriation cycles which is pretty much six months of the year. Our kids were now adults so Eileen could accompany me whenever she wanted to, and we could stay in D.C. for weekends if we wanted to. She agreed this was probably a good deal, and it turned out to be.

On one of my first trips to D.C. Eileen joined me, and we were able to rent a small apartment in the King James Hotel on Washington Circle just across the street from the Foggy Bottom Metro station and within walking distance to Georgetown and many restaurants. I could easily take the Metro to our D.C. offices in Crystal City and Eileen could easily take the Metro anywhere in the city she desired to go. We seldom needed a car, so we only rented one when we specifically need it to go on a weekend trip out of town. I felt this was pretty much ideal.

I also found the work to be very interesting and sometimes on the exciting side. The work primarily involved visiting various member of congress and the administration. The McDonnell Douglas D.C. staff had the meetings well-arranged and my job was mostly to talk about the current Space Station status and

the future benefits it would provide. Sometimes it was an elevator talk but usually it was in the congress member's office. I was always busy. I spent time studying the background and interests of the people I would be meeting with and that usually helped the conversation go easier.

We arrived at an interesting time since 1988 was a presidential election year. George H. W. Bush was elected that year and Eileen and I went to the inauguration ceremony and watched the parade from a hotel window on Pennsylvania Avenue. We were invited to attend one of the inaugural balls which of course we did. It is interesting to recall that evening and event. All the men wore black tuxedos and traveled to the ball with their companions in black limousines. Eileen and I did the same. After the event it was almost impossible to find our car and driver since everyone looked the same and everyone was looking for their drivers at the same time. Eventually we found our car and made it back to our hotel. The night before we had been to the inaugural gala entertainment event so this was indeed an exciting time for both of us.

It wasn't hard to like this duty. I met some very interesting and influential people. I learned that much of my work was simply to know these people and try to have them be sympathetic to what I needed, which of course was funding the Space Station Program. Sometimes this was to get the right value in the bill being worked in committee and sometimes it was related to the floor vote on the bill itself. Usually I was successful. But still the support for Space Station was sometimes at risk. One year the vote was very marginal with only a one or two vote edge in The House. That was too close for comfort even though we knew there were a couple of no votes that promised to switch to yes if needed. This was not a partisan issue but rather much more related to regional jobs or NASA support in general. Ultimately, we never lost a space station vote.

I had several meetings that I now think were interesting enough to write about here. One was with Congressman Claude Pepper who at the time was Chairman of the House Ways and Means committee. Normally Congressman Pepper was thought of as a senior citizen advocate but this day we were talking about space. I was having lunch with him and I was quite surprised when he wanted to talk about orbital mechanics. We ended working on his question on a paper napkin. Much to my surprise he even knew the value of pi in the equation. After lunch he wanted to show me his offices (he had two) and some of the items he had saved representing his many years in congress. At the end of our visit he said that when the space station funding comes up for a vote, they will need a rule from his

committee and that he would provide one that will be favorable. That was a very direct answer to what I was there for and so this counted as a very successful day.

Another day RoseLee Roberts, of our D.C. office, and I were scheduled to have breakfast with Senator Chuck Grassly from Iowa. RoseLee was delayed so I was alone with the Senator. I found this satisfying since we hit it off pretty well talking about farming. I knew something about that from my North Dakota days and he was interested in telling me about his farm in Iowa. He had just recently left farming to enter politics. He has since been very successful at politics and he is still in the Senate and now Chairman of the Judiciary committee. We eventually got around to talking about the space station which he said he supported even though it was not a particularly important issue in his state. Other notable members from that era that I visited were Senator Dan Quayle from Indiana and Senator Lloyd Bentsen from Texas, both of whom were Vice Presidential candidates in 1988. Later when Vice President Quayle visited California on a support for space station tour, I had the job of setting up a round table meeting for him with a group of business executives from our area. All this was heady stuff and I found that I liked it a lot.

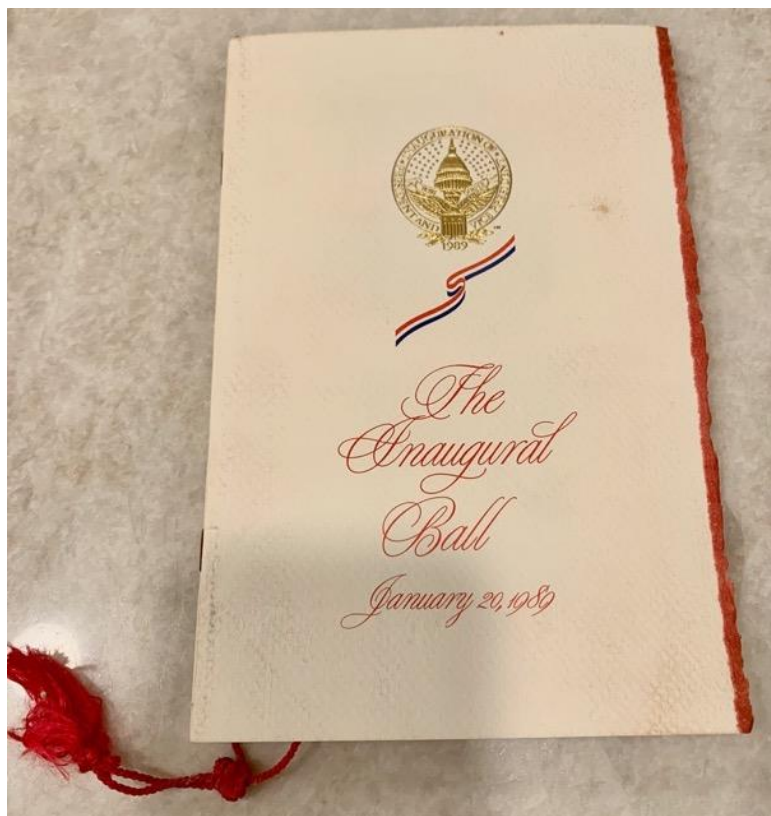
Another person Eileen and I met in D.C. was Mike Balzano who was a consultant who had good connections with VP Quayle. Mike was the sort of person you just do not forget. President Nixon had hired him into his administration after he saw an article about him in the Wall Street Journal titled "Garbage man to PhD". At that time, he had connections with the New Jersey trash collection business and Nixon felt there was political value in that connection. Mike did have a PhD and he took the job, staying on through the Watergate scandal and was still there in the late 1980's. He liked telling stories about the Nixon years and the various personalities of that era. He offered to show Eileen and me around the administrations executive offices. We did this one evening when most of the people had gone home for the day. This included a tour of the White House west wing and the old executive office building across the street. We visited the oval office and spent some time in the press conference room where we had our pictures taken at the spot from which the President usually spoke to the reporters. I suspect it would be nearly impossible to do this again today with all the current security requirements.



In the press briefing room, 1989



Space Station briefing 1989, Washington D.C.



Inaugural ball mementos, 1989

Chapter 23: Space and Defense Systems Organization 1992-1994

In about 1992 McDonnell Douglas made a significant organizational change which divided their businesses in two major sectors: One was MD East with headquarters in Saint Louis and the other MD West with headquarters in Long Beach. Each was led by an Executive Vice President. I was initially assigned as Senior Vice President, Space Systems and later with the addition of certain defense programs this was changed to Senior VP Space and Defense Systems. This was the highest organization level I achieved in my career. I reported to Ken Francis, the MD West Executive VP. I had known and worked for Ken several times before, most notably on Skybolt back in the early 1960's. By this time my long-standing boss and mentor, Jim Dorrenbacher had retired.

In this new position I had responsibility for all of our space programs in Huntington Beach and other locations such as Huntsville and Houston as well as a number of mostly classified defense programs in Huntington Beach. The scope of this was huge and it consumed every bit of my physical and mental abilities. And of course, it included the Space Station cost troubles. For the most part these were successful businesses. The profit level was as good as or better than most other areas in the Corporation despite the Space Station problems. I was usually able to report significant new business additions. My quarterly reports to Corporate Headquarters were always well received.

My job was not always fighting the problems. There was interesting travel to visit foreign countries and companies in search of new markets, new partners, and new technologies, as well as attending business conferences. Overall, my business life was good. As an example, Ken Francis and I, plus several others traveled to Russia in 1993 or thereabout to visit some engineers we had working in Moscow to evaluate some possible use of the Russian aluminum lithium alloy material technology. This was a very interesting trip.

After the USSR collapsed in 1989, Russia became a very open territory for business from the West. In our case we were interested in their aerospace materials technology, which at that time appeared to be better than anything we had. The Russians were very willing to show us what they had and sell it for a price that seemed quite reasonable. In about the 1991-1992, we decided to set up a small group of technology engineers in Moscow near the University to better evaluate this. We found an available old building and refurbished the second floor for this use. This area ended up having some offices, a conference room and a large kitchen area that served as both a food preparation and eating area. There

was a large dining table covered with a smooth shiny cloth material much like I recall from my early days on the farm in North Dakota. We installed some relatively modern appliances and hired a Russian cook. The engineers ate most of their meals here since it was usually better than anything else they could find locally. The engineers were generally making good progress on their assignment and the reason for the visit was primarily to sign an agreement relative to our use of this material in one of our planned future advanced aerospace systems. But we also allowed plenty of time for visits to points of interest in both Moscow and Samara, an aerospace city to the East. Our host was the head of the Materials department at the University of Moscow and his staff.

When we arrived at the airport we were met by our host and quickly driven to our hotel in a Russian Zim limousine. Ken and I were assigned to ride in this car for the duration of our visit. Along with the driver we also had an assigned armed guard. In the early years after the USSR breakup Russia was on the lawless side and most businesses needed to have guards for protection. Our host wanted to be sure nothing bad happened to us and thus assigned this guard who was always with us. If we were out walking, he made sure there was space between us and anyone else. Luckily, we did not encounter any lawlessness during our visit.

We had business meetings in our building near the university and eventually signed an agreement. It felt a bit weird in the conference room since the remodel had retained the Russian tradition of a large picture of Lenin on the front wall looking down on the proceedings. On the evening after the signing we had a party around the large kitchen table. In addition to our host it was also attended by some officials from the Russian space agency. We had language translators in attendance and following the Russian tradition there was much smoking, drinking and dirty story telling. None of this fit me very well but I played along as best I could while still trying to avoid drinking too much. Anyway, we all survived to work and play another day. While in Moscow we also took a river boat tour and visited some of the buildings within the Kremlin walls. We visited the place where Lenin is buried and where Nikita Kruchev is buried. Following this we visited a flea market and bought a few things to take home.

After our Moscow visit was completed, we flew on a Russian airplane to the city of Samara, which is an aerospace manufacturing center, located on the Volga River about 800 km to the east of Moscow. This city was an important airplane manufacturing center during WWII. We were guests at one of the design centers that produces the Soyuz launch vehicle. The facility was a sorry state of disrepair as was the case for much of Russia at that time. It was hard for me to believe that

the very reliable Soyuz rocket was built here but in fact it was and still is. We enjoyed the visit and shared rocket launching experiences which was fun. The Russians put us up in a very large mansion overlooking the Volga River. I was assigned a huge suite which included a bedroom, bathroom, dressing room and a huge living/dining room that seemed as large as a dance hall. The day after our business meeting they took us on a Volga River boat trip which included plenty of drinking. After that they decided we should all have a party in my suites' living room. This was not my preference, but the situation was completely out of my control. I played along for a while and then went to bed the rest of the group, including all the Russians, partied well into the wee hours of the morning. After recovery the next day we visited a bunker that had been built as a WWII command center for Stalin if he had to abandon Moscow to the invading Germans. The Russians were able stop the German advance short of Moscow, so Stalin never used this bunker. Following that we visited a Russian metal forging factory that was very impressive and then returned home. The technology agreement with the Russians worked out fine and we purchased an aluminum lithium tank from them for use on the DC-XA reusable rocket.

Back in the US, the Space Station cost issues remained. NASA had a new administrator and he insisted McDonnell Douglas was at fault. He told our CEO that a high-level person at MD would need to step aside. Since NASA remained a major customer our CEO could do little other than comply and this fell on me. This time I was not lucky and was in the wrong place. I accepted a reassignment to VP General Manager of Advanced Space Systems and Technology with no change in compensation and there was very little or no downside. In fact, the new position offered a lot of very interesting work. As I look back now the senior VP position I left behind continued to have more troubles with technical and cost issues in the launch vehicle side of the business. I was able to stand clear of that and move on with my remaining years. It all ended up well.



A visit to our hosts country house.



Our group near the Kremlin



Russian metals factory



Business meeting in Russia. Also note the portrait of Lenin looking down on the meeting.

Chapter 24: Advanced Systems and Technology Division 1994 - 1998: DC-X 1995-1996

I was assigned to the position of VP Advanced Space Systems and Technology as my last executive position prior to my first retirement in early 1998. There was substantial responsibility in this assignment as I was in charge of allocating and overseeing expenditure of all new business funds for Space and Defense systems including that for both independent R&D and new business proposals. In this time period a considerable amount was being allocated for the new larger Delta IV space launch vehicle.

Delta IV was by far the largest launch vehicle I had ever been involved with and to this day it remains the largest space launch vehicle in the US. Back in this era it was still in the design concept and view graph stage. My teams' task was mostly that of sizing the vehicle and selecting the best engine. We needed a large payload capability yet also have the flexibility to meet a range of both military and commercial requirements at the lowest possible cost. We initially had two competing engine designs. One proposed by Rocketdyne and the other by TRW. Both used hydrogen/oxygen propellants. Over time I became convinced that the Rocketdyne design was the only practical approach. The TRW design was less complex, but it was heavier and required far more propellants. This of course translated into much larger vehicle tanks and everything else that goes with that. I felt it would be best if we made a down select to the Rocketdyne design as early as possible. With this decision everything else would fall into place in a more reasonable way. The engine selected was called the RS-68. Eventually this design worked out to be three common core stages fired together for liftoff and was called the Delta IV Heavy. Other configurations used only one liquid fueled core plus added solid motors. All configurations used a hydrogen oxygen second stage derived from the Delta III. After this initial concept and preliminary design phase was completed an Air Force contract was won and detailed design was completed under that contract. The first flight was conducted in 2004.

Another exciting advanced launch vehicle developed in this era was the DC-X Delta Clipper. This was a reusable rocket which demonstrated hardware reuse with rapid flight to flight turnaround similar to an airplane. This was the first flight vehicle in what was called "single stage rocket technology" (SSRT). I recall Bill Gaubatz was working to obtain a DOD contract for this project and he asked me to join him for an important meeting in D.C. related to this. When I entered that meeting, I found an Air Force acquaintance (Jess Sponable) from the PAM days

who was working on this for DOD. It wasn't hard to convince Jess that our team was the right one for this effort and shortly after we received a DOD contract for the project. DC-X was developed by our team using the same rapid prototyping process that previously proved to be so successful on Delta 180. The vehicle was conical in shape, used four RL-10 hydrogen oxygen engines and took off and landed vertically. It was flown at the White Sands New Mexico testing range and its' flights received wide industry and national attention because of the unique reusability and rapid turnaround. Another interesting aspect of this project is the role of Pete Conrad. Pete was one of the Apollo astronauts and the third person to set foot on the moon. After he left NASA Pete was working for McDonnell Douglas and had been assigned to my organization. One day Pete came to my office and asked if he could be assigned to the DC-X project and to operate the vehicle from the test control trailer. Pete had been a master of flying machines throughout his whole life so of course I said yes. As time went on NASA also became interested in what the DC-X team was doing and contracted with us for a second-generation reusable vehicle called the DC-XA which used new advanced propellant tank technology. Later NASA generated a research plan for an even more capable reusable vehicle which was called the X-33. Lockheed Martin bid against us for this contract and since they were willing to allocate more of their own money than I was able to generate from McDonnell Douglas they won this NASA contract. However, it turned out that Lockheed Martin over committed what they could achieve and in the end the contract was cancelled without ever getting to the first flight stage.

During this period President George H.W. Bush wanted to support the future of space and ordered the Space Exploration Initiative (SEI). This was primarily to generate a road map for the future with a return to the moon and an ultimate goal of sending humans to the planet Mars. NASA formed a top-level Government /Industry team to develop this plan called the "Synthesis Group" which was led by Tom Stafford, a former Apollo program Astronaut and a good friend. I was a senior member of this group and my advanced systems team did a number of studies to support the activity. This also provided the opportunity to attend and present SEI papers at several space conferences. This was almost thirty years ago, and NASA is just now developing the hardware for the first part of this plan for a return to the moon.

Part of my work was also to develop our future business strategy. During this period this was not easy since there was more industry capacity than there were new business contracts. The Aerospace business had been in a consolidation mode for a number of years and still more was necessary. This was especially the case in

the manned space area. As I went about studying the future for us in manned space, I could see it would be bleak unless we could consolidate with another company doing business in this area. I decided our best shot would be if we could work out something with Boeing. I laid out some thoughts on this that I put into the strategic plan briefing. Several weeks later our CEO Harry Stonecipher was at Huntington Beach and I was briefing him about this plan including the ideas about consolidation with Boeing. I could tell Harry was uncomfortable with what I was briefing but I could not figure out why. He kept looking at his watch and commenting about the fog that was coming in which might delay his outgoing flight. Finally, he said he feared being delayed by the fog and would have to leave earlier than planned. With that the meeting finished and he left. It was only the following Sunday that I learned that a merger of Boeing and McDonnell Douglas had just been announced. At that point I understood why Harry did not want to be openly talking to me or anyone else about consolidating with Boeing. He had already just worked out the deal. The merger took place shortly thereafter.

Now being a part of Boeing, the Sea Launch program became important. This was a new launch vehicle derived from the USSR Russian/Ukrainian Zenit ICBM. Sea Launch was a commercial launch program and Boeing was a major investor. It also used a fairing designed and built by Boeing in Seattle. John McLucky was now in charge of Space for Boeing and he sought my help and advice on two Sea Launch issues. The first dealt with the fairing which was the same diameter as the Delta III fairing being produced in Huntington Beach. John asked why one design could not be used by both Delta and Sea Launch. This was a good question, so I made a trip to Seattle to understand the Boeing Sea Launch fairing. I quickly found that the Sea Launch flight loads caused the Boeing fairing to be a much heavier design than the Delta III fairing. The Delta III fairing could not be used with Sea Launch flight loads and the Sea Launch fairing was too heavy for Delta III. Dual compatibility was impossible so that answered the question. The second issue was a recent flight failure of the Zenit caused by a Russian designed engine. John wondered what that meant for Sea Launch which used the same engine. He asked me to join a Rocketdyne engineer on a trip to Moscow to see what we could learn about this failure. That turned out to be the first of many trips I made to Russia related to Sea Launch. In this case the travel went well but the Russians were very evasive to our questions. About all we could do on this first trip was to set up the agenda to get answers on what they were willing to discuss on a second trip. It took two trips to answer relatively straightforward questions. They had some recovered hardware from the flight which along with the acceptance test data left little room for doubt. It was a condition that should have been noted from the engine acceptance test data. In any case actions were taken to prevent this from

happening again on Sea Launch so John McLucky was satisfied, and I was free to go on to think about retiring.



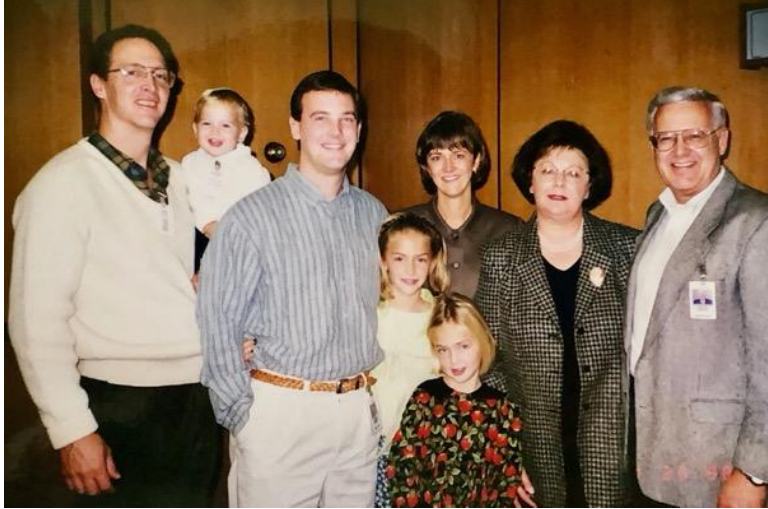
Flying DCX, 1995

Chapter 25: First Retirement 1998

In the 1990's the US Air Force held a competition for the Joint Strike Fighter aircraft (F-35). This was the most important military aircraft contract for the foreseeable future. McDonnell Douglas lost the competition and that set the stage for additional consolidation within the aerospace industry. In December 1996 the merger of Boeing and McDonnell Douglas was announced. Once this merger was approved in 1997 the new combined organization became known as The Boeing Corporation. Overall, this was good news. However internally there was much work to be done in fusing these two great companies. Executive teams were formed to evaluate the resources and how they should be combined into the new company. I played a part in this however I also knew that I was now at a career point where I should soon exit the scene (i.e. retire). For McDonnell Douglas the corporate rules and regulations were that this merger constituted a "change in control". This meant that previously granted MD deferred stock would immediately vest when the merger was fully approved. For me this certainly made the financial aspects of retiring even easier. Through 1997 the new organizational arrangements were coming more into focus and it was obvious that a lot fewer Vice Presidents were needed. By October 1997 I would be 63 years old and there was little reason for me to stay on. By the end of 1997 I decided I would retire, and it was agreed that would take place the end of January 1998. In January John McLucky asked to see me. We had a meeting at which he told me he really didn't want me to leave and offered me a VP position on his staff. But by that point I had made a final decision and wanted to retire. He accepted that, thanked me and I left fully relieved.

After that I knew I was free to go. With the new organization I knew there were others to carry on where I was leaving off. Nothing would fall through. Therefore, I retired at the end of January 1998 at the age of 63 having spent 41+ years in the aerospace business during some very exciting times. On my last day in the corner office of building 11 at Huntington Beach my family all came to join me for final pictures in my office and together we left that last day. A few weeks later my family, friends, co-workers and others from across the industry had a wonderful retirement party for me at the Huntington Beach Waterfront Hilton Hotel on Pacific Coast Highway — This was a fitting setting as the ocean was the one I had longed for so many years before from North Dakota the 1950's. I was happy and satisfied.

This was truly the end of my work as an aerospace executive but not as an aerospace engineer. Eileen and I took a breather at this point and we of course knew nothing about what was yet to come.



Even my Grandchildren came to my “last day” at work, 1998.

Chapter 26: World Travel, Conferences and Vacations (not covered elsewhere) 1975 - 2015

One of my favorite work events was the annual Goddard Memorial dinner that is a black-tie event held annually in the Washington Hilton Hotel. I always attended this great gala and often Eileen joined me. The entrance color guard and front table attendee's introductions were always something to remember. The dinners and speakers were always very good and the party afterward was always a lot of fun. As I write this, I cannot help but remember the guest drop off/pick up area that we usually used for the event. This was the place where President Reagan was shot as he left the same hotel back in the 1980's.

Once I had retired it became easier to think about more travel and reflect a bit more on what we had done in the earlier years. Eileen and I have always managed to fit traveling into our lives. Sometimes this was in conjunction with work and sometimes it was simply personal vacation. During the first several years after retirement we made three or four vacation trips every year.

In the period when the children were at home, we usually had all we needed or could handle with local vacations at our mountain cabin or down to San Diego. This was primarily the period up through about 1985. During this period Eileen almost always stayed with the kids while I traveled with work. We did take two or three trips together that I recall. One was to Hawaii, one was a cruise through the Panama Canal and one was to Washington D.C. after a Delta launch in Florida. Kevin went along with us to both Florida and D.C. Charlotte was in college so she stayed home to focus on studying. During this period, I had some memorable experiences with foreign travel related to work. Two trips to Cairo Egypt remain especially strong in my memory. They were in the 1978 - 1980 time period and I traveled there related to selling a PAM for Arabsat (a communications satellite for that part of the world). Both trips were difficult and a bit on the frightening side. In both trips I had a traveling companion and we were met by a guide who also acted as a driver to take us from place to place. On the first trip I traveled with Bud Schmidt of our marketing office and our flight arrived quite late in the afternoon. Our driver met us and from there it was pretty much chaos for the rest of the evening and into the night. First, we found that our hotel had been bombed and was closed. In those days there was a lot of friction between Egypt and Libya and this was apparently a part of that. It was not a simple matter to find another place to sleep that night. Our driver/guide tried and tried. The phone connections were so bad he sometimes just threw the phone down. This sure didn't look or feel

good to us and I was so tired I just couldn't think straight as I wondered what was going to happen next. Finally, it was nearing midnight and I thought we should just sleep on the couch in the Hilton hotel if they would allow this.

About this time our guide said he had found something and to get back into the car. We drove for a while and then came to a structure that appeared to be an apartment building still under construction. The owner or someone from the building met us, took us up a couple of stories and showed us a small apartment where we could stay. As I recall there was one bedroom with two beds plus a bathroom, a small living room and a balcony. There appeared to be decent sheets and blankets, so we said ok. He wanted to be paid in advance, so we agreed and he went on his way. We never saw him again. I have no idea to this day if he actually had the right to rent us this place for the night or not, but we were at least relieved to have found something. Our guide said he would be back to pick us up in the morning and left. Bud and I had a drink on the balcony and then went to bed. The night went ok but in the morning the bathroom did not. First, the floor was covered with dirt from construction in that area. Next, the water line started to leak all over the floor. The dirt turned to mud, and we had to put our shoes on to even be in the bathroom if that is what it could even be called. There was no one to call since this was not any regular hotel. I don't think there even was a phone. As soon as we could we vacated the bathroom area and went out on the balcony to wait for our driver to show up. It was now daylight so we could see more of what was below. In the parking lot there was what appeared to be some wrecked Soviet army vehicles. With this and the trauma of the night before we wondered what was going to happen next. Fortunately, our driver arrived when he said he would and got us to our meeting on time. Following that we were able to get a regular hotel for the next night and then were able to leave Cairo the next day without further incident.

On the second trip to Cairo I traveled with Larry Gale. On the plane we met a man that claimed he was a businessman. He claimed to have an English wife and live in an English estate. During the conversations he learned that we were in US Aerospace. It was not good that he found this out as we learned later. Again, I had trouble with our planned hotel. They had sent a message saying they no longer had rooms for us. The overall hotel situation in Cairo was no better than for the first trip. Anyway, this businessman we had met learned of this and said he wanted to help. When we arrived at the airport our driver/guide was there, and this man told him to follow his car and he would get us a hotel room. So that is what happened. We arrived at a very nice Meridian hotel overlooking the Nile River. This guy got some packages out of his trunk and went into the hotel. He soon returned and told us he had arranged for one room for the two of us. He had bribed them with

whatever he had in his trunk, but for the moment Larry and I were happy to at least have a room. There were two beds so it worked out alright. We thanked this guy and he left. Larry and I talked a bit and wondered what had happened but we were thankful for somewhere to sleep. We slept well.

The next morning, we received a call from this same guy asking to have lunch with us. We gave some excuse and then decided we really needed to avoid any further contact fearing only trouble would result. We went to our meeting which was over quickly and we had all afternoon before our flight out. We figured we needed to keep on the go until the flight in order to not have to meet up with the “businessman” from the flight again. We had both been briefed to not get into this type of situation when on foreign travel and knew we needed to get out of there before anything else along this line happened. So, we told our driver to take us on the tourist circuit for the afternoon. He did this and we ended up at the Giza Pyramids. There we joined a group of Egyptian tourists and started up the small dimly lit tunnel going inside the pyramid to the center burial chamber. With all these people in the tunnel it was terrible, there was no going back and going forward was extremely slow plus the Egyptian tourist guide kept yelling to keep moving but this only made matters worse. We finally got to the large chamber and could again move around. But then some of these Egyptian tourists decided that Larry was an American movie celebrity. They just kept surrounding him until we finally escaped back down the tunnel. From there we made it out of Egypt without further incident. But this was certainly enough. Upon our return to the U.S., we told the McDonnell Douglas security people about what had happened in Cairo, but we never heard anything more about it.

Making all these trips worthwhile, we did finally sell those Arabsat launches.

In 1986 Eileen and I decided to take a North Sea cruise. It went as far as Leningrad Russia (USSR). I asked the McDonnell Douglas security people if this would be okay. They said I could go but I could not go ashore in Russia. (This was before the USSR came apart). They said Eileen could but that I could not. We agreed that was ok and went on the cruise. When we got to Leningrad (now St. Petersburg) I stayed on the ship while Eileen was able to tour the great sites of that old Czarist City. She said she felt uncomfortable going through the Russian customs guards but ultimately was ok and returned safely to tell me all about it. I got to see these things myself later after the USSR collapsed in about 1989.

In about 1995 Eileen and I had an interesting time on a trip through Italy and on the French Riviera. I had a work conference to attend in the Italian Alps and about

two weeks later a second conference in Nice, France. The time between could be for personal vacation so Eileen went along. We arrived in Milan and rented a car. Most of the cars had manual transmissions and we wanted one with an automatic transmission. It turned out this was a mistake, but we waited until one arrived (a Fiat) and we were on our way. The next day we made our way on the main highway up into the Italian Alps to a magnificent castle like hotel near the German border where the conference was held. We enjoyed this place immensely. The views in every direction were unbelievable. We stayed there several days and then it was time to leave. It was late May and we learned that the Tonalli Pass down the mountain had just been opened for the summer season. We thought it would be a good idea to take this road since there would be more new things to see. Our destination for the day was Lake Como. But what a day this was. This was an extremely narrow and winding road with sharp unprotected drop offs to heaven only knows where. I think we must have been the only ones in that part of the country, and I am not sure what we would have done if our car had failed that day. We were quite frightened driving this road and while the views were fantastic our thoughts were mostly to get through this safely. It took all day but by the end of the afternoon we were safely down the mountain and onto a normal road that took us to Lake Como. Once at Lake Como, we weren't sure where we might stay since we had not made prior arrangements. We kept driving along the lake until we came to a very old hotel. We stopped and went in to see if we could stay there. This hotel was old but had been very elegant in its' day. Part of that elegance remained and we were lucky as they said they had the corner room on the second floor available for the next few days. We had planned to go to Venice, but we were tired at this point and decided we would simply stay here for a few days instead. So, we got our things up to this room and went to bed for the night. The next morning, we had a wonderful surprise. We opened the giant shutters on the windows and saw the great view across the lake and to the snow-covered mountains beyond. We could go out on the balcony and experience this all day long. We were so happy. As planned, we stayed there a few days very satisfied to be by ourselves, to experience the lake and local tourist sites and meet the local people, some of whom spoke English. We felt no reason to leave but of course in a few days we did.

We then drove down through central Italy without incident with our destination being Nice, France on the Mediterranean Sea. Our problems began at the border between Italy and France. We stopped for a while to stretch our legs and when we got ready to leave this Fiat car simply sputtered and stopped running. There was no getting it started again. Also, it was hard to find anyone that spoke English. It took a long time but finally we found someone that helped us make a phone call to the car rental agency. They told us to leave the car and take a taxi to their agency

in the next town and so that is what we did. Once there, they provided us with a very nice Mercedes for the rest of our trip. We then happily made our way to our hotel in Nice. The conference went well and near the end we had a wonderful evening in Cannes. It was at the time of the Cannes Film Festival and our group from the conference was invited to attend a showing of the award-winning film the night after the main film festival event. This was a once in a lifetime event for us and the night was greatly enjoyed. They still had the red carpet laid out at the entrance to the theater along with the formally dressed attendant personnel along the carpet. We were welcomed by the mayor to walk up the red carpet to the theater just as the celebrities did the night before. There we attended a cocktail hour and then the movie. It was a Swedish film without subtitles so we could not follow it very well however on the bus back to the hotel others that understood the language explained it to us. Another day our conference group had a banquet on a ship in the harbor among all the yachts that were there for the film festival. Indeed, this was quite a unique experience for us. We stayed another couple of days to spend time relaxing on the beach and then we were on our way back to the airport and headed home. This was truly a vacation to remember.

I always enjoyed attending the Paris Air Show. The technology displays, the actual airshow and all the food and drinks were all amazing. One year in the 1990's Eileen traveled to France with me for the Paris Airshow. We stayed at the Intercontinental hotel near the Tuileries Gardens. Eileen went on a tour nearly every day. In the two weeks or so that we were there she saw a lot of that area. One weekend we went together to visit the Normandy WWII invasion beaches. A great experience of history.

We had two very memorable family celebration trips. The first was a trip to Alaska in 1998 to celebrate my first retirement. Eileen and I were accompanied by our children and their spouses (Charlotte, Tim, Kevin, and Peaches) along with my sister Susan and her husband Roger Eggen and Eileen's niece Judy and her husband Paul Schmoll. The trip included a train trip to Denali park and a cruise along the Alaska coastline back to Victoria and Vancouver. There were many fun memories including a helicopter trip to a glacier, float plane flight to an inland lake, ocean fishing, cog train to an old gold mining area, touring Victoria Island and a middle of the night stop by our cruise ship to rescue some stranded wave runners.

The second family trip was in 2007 to celebrate our 50th wedding anniversary. Our children and their spouses (Charlotte and Tim, Kevin and Peaches) and our

grandchildren (Caitlin, Taylor, Carter and Erik) all joined Eileen and I for a two week tour of the Hawaiian Islands. This involved a cruise ship visiting each of the islands along with shore trips on each one. We had a very good time throughout the trip, but the first night on the ship was especially noteworthy. We gathered together and Eileen and I told them the history of our ancestors and when and how they came and settled in America along with how they raised the two of us. After that we gave each an envelope with cash to do the things they wanted to do for the rest of the trip. Everyone was pretty satisfied. Eileen and I were very happy to have had this opportunity.

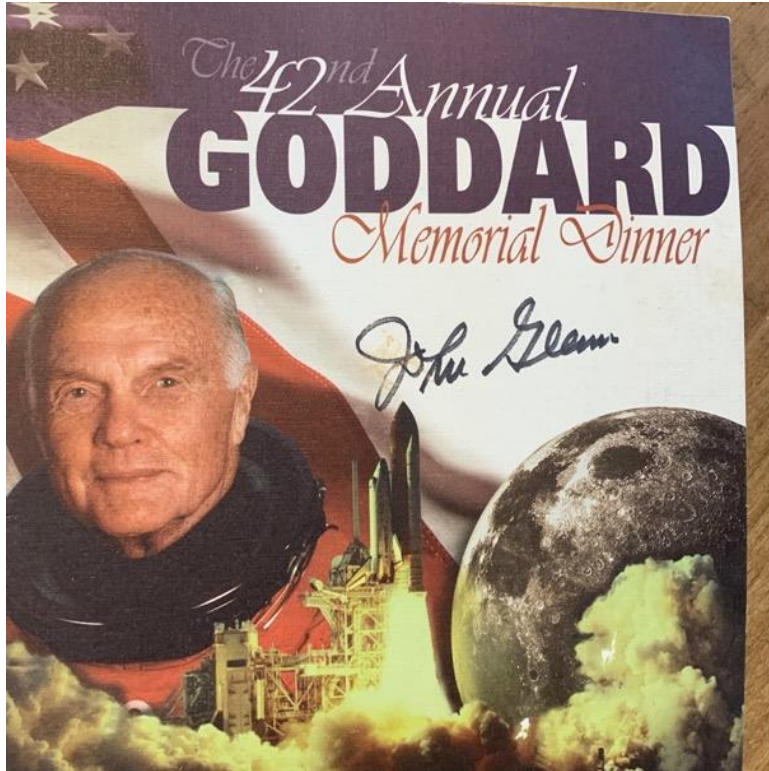
After I retired, we took two trips to Norway and visited my family ancestral farm on Lake Jølster. My relatives still live there. We visited the small log cabin site in the mountains where my great grandfather once tended sheep, goats and cows so many years ago. The cabin was rebuilt in the “old way” with hand hewn logs and a grass sod roof. There was a rushing mountain stream nearby fed by the nearby glacier. This was such wonderful beauty as well as history. After the farm, we traveled the coastline and fjords in a coastal cruise and supplies delivery ship. Charlotte and Kevin joined us on one of these trips.

One-time Eileen and I took two back to back cruises from Venice up through the Dardanelles into the Black sea. We spent a lot of time in Istanbul, visited several the Balkan countries and visited the site of the WWII Yalta conference between Stalin, Churchill and Roosevelt.

By about 2000 we had traveled most of Europe and so we turned our attention to the Pacific and Asia. We took one really great WWII remembrance cruise in which we visited most of the major island invasion campaigns against Japan. This cruise was filled with many veterans of those campaigns and they presented lectures and group session discussions about those events. The cruise started in Hawaii at Pearl Harbor (site of the attack that started the war) and ended with visits to Hiroshima and Nagasaki Japan (sites of the atomic bomb use that ended the war). This was a once in a lifetime opportunity that we thoroughly enjoyed.

Beyond this we traveled extensively in China, Korea, Southeast Asia, Australia, Singapore, New Zealand and South America. We especially enjoyed New Zealand for its’ old-time like hospitality. You cannot buy anything or do any business without first taking time to talk about who you are and why you are there. They simply have a culture of person to person friendliness that you seldom find elsewhere.

I will make one last comment in this section. During the visit to Melbourne I was honored to be accepted as a Fellow in the International Academy of Astronautics which was a long held personal goal. There were many friends from the international space community in attendance and the banquet was indeed a great celebration for both of us.



Goddard dinner souvenir with John Glenn's autograph which he signed for me.



AT WASHINGTON CEREMONY, from left, Theodore D. (Ted) Smith, Robert L. Johnson, C. A. Ordahl, L. W. Gale, E. W. Bonnett, and NASA administrator James C. Fletcher.

Receiving a Delta award at the Goddard dinner.



Pyramids near Cairo, Egypt



Exact replica of the original cabin built by my great grandfather in the Norway Mountains.



Celebration cruise to Alaska after my first retirement, 1998



Family cruise to Hawaii to celebrate our 50th wedding anniversary, 2007

Chapter 27: Delta and Sea Launch Consulting, 1998 - 2015

I retired from executive work the end of January 1998 and remained fully retired for a little over six months. I spent my time doing delayed projects at home and traveling with Eileen. One day in August, I received a call from the Delta proposal team. They were nearing completion of a proposal to NASA and asked me if I would return to help them by leading a Gold Team review. I felt I was ready and happily said yes. This began another long run of very interesting work as a consultant in areas I knew well.

The Delta proposal to NASA was successfully completed and almost immediately thereafter there was a failure of the Delta III (Delta 259) in its' first flight. Delta III was a very large upgrade of the Delta. It had a new hydrogen oxygen second stage and a new large fairing. It had large solid rocket motors with thrust vector control. It resembled the Delta II mostly in name only. During this first flight a torsional control instability problem developed early in the flight which exhausted all the solid motor hydraulic fluid causing loss of solid motor thrust vector control. This almost immediately caused structural breakup and the flight was a total loss. The flight never got anywhere close to the point of firing the new second stage. The engineers knew almost immediately what had gone wrong. A major error had been made in the control system design. The controls engineers assumed the torsional structural modes would be the same as a Delta II and used that assumption in their Delta III design. But in reality, these modes were far different due to the larger solid motors and associated structure. As the propellants were expended the torsional mode gain increased to a point where the control system simply went into an unstable limit cycle using up all the hydraulic oil in the solid motor's blow down system. The structural engineers knew this larger vehicle had a different torsional mode but there was a breakdown in communications of this to the controls design group and the controls engineers failed to even ask the right questions. It was hard to hear the details of this sad situation. I was once again asked to stay on to help in the investigation and of course I did. The technical facts and the flight data were clear. There was really no question except why the engineers had made such a mistake in both communication and judgment. This was a very large example of what I had come to call the "Heritage Design Trap" when evolving launch vehicles into larger and different configurations. Had Delta III been considered a completely new vehicle the processes used would have prevented this mistake but alas, this was not the case. There really was not much for me to do in this investigation other than to tell them what they already knew. New processes would be put in place to prevent this from happening again. There was more to do in working toward assuring a successful next flight which should

reach the point of using the new second stage where we felt the highest risk remained.

A full design review of this new Delta III second stage was conducted in preparation for the next flight. I participated in this review and it was here that I met John Silverstein, who has space launch experience similar to mine (he worked at General Dynamics on similar space programs). John is a remarkable engineer. We have worked together for years and together we probably have an unmatched amount of space launch vehicle experience.

Unfortunately, the next Delta III also failed. The investigation revealed that the cause was a second stage engine quality escape. An engine structural joint did not have a correct braze which was not detected in the X-rays. In addition, there was ambiguity in the drawing requirement for the amount and area distribution of the braze material. It was never completely clear why this did not show up in the acceptance test ground firings. Prior to the next flight, the braze joint was corrected and several other design improvements were implemented along with a full requalification of this engine. This was costly and took a lot of time. The next demonstration flight was successful, but the Delta III was never again used to carry an operational satellite. The main result of this program was the second stage, which was later used for the successful Delta IV. Subsequently Delta became a part of the United Launch Alliance (ULA) and the amount of my consulting support required was reduced.

In 2010 my final Delta work was a briefing of lessons learned from Delta failures over the decades and how the corrective actions improved the Delta reliability. I presented it to ULA engineers as a part of their training program.

John and I went on to provide launch readiness review support for the Sea Launch program. The Sea Launch vehicle was developed by the Russians and evolved from a Ukrainian ICBM. It was managed by a commercial company with its' main facility at the harbor of Long Beach. The launches took place in the mid Pacific from a floating platform. John and I usually supported two reviews for each mission in Long Beach. The reviews were very different for us since there was considerable technology transfer control over anything we thought or wanted to express. Our assessment reports were only given to U.S. employees who then decided how to best relate this to the Russians following U.S. technology control protocol. This program had a mixed reliability record in part due to the problems with the root cause and corrective action process employed by the Russians. When a failure did occur the investigation reviews typically required John and I to travel

to Russia, usually Moscow. These were always very interesting trips. We usually flew on Delta Airlines overnight from Atlanta to Moscow and always stayed at very nice hotels near the center of Moscow. Our Russian hosts usually took us by bus to the meetings at their facility. Strong U.S. technology transfer control was always in place and along with language translation these meetings went very slowly. But the time in Moscow was always very enjoyable and we often took long walks near the Kremlin or for shopping or simply for sightseeing. One time our hosts took us to their space museum. They were rightfully very proud of this history especially back in the late 1950's and early 1960's (Sputnik and first human space flight). Occasionally these reviews also took us to Ukraine, which involved more difficult but still very interesting travel. In many cases there were the after-work parties with drinking and storytelling.

I recall one trip when Eileen wanted me to purchase a large number of hand painted Russian boxes- something that she was collecting. By the time I had completed this I had a carry-on luggage case filled for the return trip. I wondered what would happen at U.S. customs, however when I told the customs officer what was in the luggage he simply shrugged, smiled and waved me on.

I did this type of consulting work until about 2015 when the Sea Launch business declined.



Consulting with Jack Murphy, myself, Clarence Quan and John Silverstein.

Chapter 28: Ground-Based Midcourse Defense (GMD) Program 2000 – 2019

The Ground-Based Midcourse Defense (GMD) system is the central element in the Ballistic Missile Defense System (BMDS) which forms the operational defense of the U.S. homeland against intercontinental ballistic missile threats. The BMDS system is the global implementation of President Reagan's vision of a homeland defense against these long-range threats and the reason he set up the Strategic Defense Initiative Office (SDIO) back in the 1980's. SDIO later became the current Missile Defense Agency.

In the early 1970's this type of defense employed atomic warheads, as in the Spartan/Safeguard system, however this approach was ultimately outlawed by international treaties. During the 1970's and 1980's additional technology research showed that direct high velocity exoatmospheric "hit to kill" was possible. This is sometimes referred to as "hitting a bullet with a bullet". Portions of this were demonstrated in the Delta 180 experiment in 1986. In the 1990's the first phases of the GMD program demonstrated this capability using representative boosters, kill vehicles/sensors/software and targets. This was sufficiently successful for President Bush to authorize a full operational system be designed, built and deployed in the 2000's. The GMD technology is very complex. It involves a highly integrated and automated system of space-based sensors, ground based radars, fire control /battle management computers and interceptor missiles consisting of multistage boosters carrying a kill vehicle with its' target hit sensors, propulsion and guidance software. Data flows between the systems elements via a global communications network. The main operational interceptor field is at Fort Greeley Alaska while the flight test interceptors are launched from silos at Vandenberg AFB California. The flight test control center is at Schriever AFB near Colorado Springs. Fire control is performed with computers at both Colorado Springs and Fort Greeley. Boeing has the prime lead integrating contract from the Missile Defense agency (MDA). Other major contractors are Raytheon and Northrup Grumman.

Similar to the early ballistic missile programs, in order to meet national security needs, the GMD operational design, production, deployment and system flight testing were conducted concurrently. As in the early ballistic missile days this led to a period of technical difficulties which had to be overcome - and they were.

My involvement with GMD started in 2000 when I was asked to join a small team chartered by MG Nance (the Program Director) to review the booster design. This was originally planned as a one-week effort but rather quickly increased to six or more weeks as the number of design issues expanded. We visited a number of contractors and then completed our report by about mid-year 2000. Most of our recommendations became a part of the final booster design.

Subsequently in February 2001 I received a call from Dan Hart (Boeing GMD engineering) asking me to assist him in the investigation of a booster flight test failure (BV-3). Dan had once worked on the Delta team. I agreed and that began my long and often rather intense involvement in this program. This booster failure was an explosion of the first stage solid motor. The cause of this type of failure is always difficult to determine since the event happens so fast and there is usually very little flight data recorded. The cause here turned out to be transportation handling damage of the solid motor. The work related to the BV-3 booster problem took the best part of a year. During this period, we did a full simulation of the missile handling and were able to fully recreate the cause of failure. This type of transportation handling was eliminated for the final operational booster.

Following the BV-3 work I was asked to support the investigation of a kill vehicle to booster separation flight failure (IFT-10) which occurred in December 2002. In this design the separation is a kill vehicle function. The kill vehicle (EKV) is designed and built by Raytheon in Tucson, AZ. This was the beginning of my many years working with Raytheon solving EKV problems. The cause of the IFT-10 failure was an electronic unit design change without proper requalification.

Between 2004-2005 there were two failures to launch the interceptor in system level flight tests. One was caused by silo ground support equipment (IFT-14) and the other by a booster software error (IFT-13C). The root cause of both failures was in design and both should have been found in acceptance tests before the mission. The return to flight after these major problems took almost two years.

In about 2005 Boeing decided to set up a small independent review team, called a program independent assessment team (PIAT) to work across the program providing technical assessment and guidance wherever needed. At about the same time MDA decided to form a similar team called the Independent Readiness Review Team (IRRT). I became a member of both of these teams as the work was very similar. This was a very interesting assignment as it allowed me to work across the entire program at all different levels from the engineering teams to the MDA Director (three star general).

From about 2005 to 2010 there were a number of flight tests to prove out the overall system design including the radars and fire control elements. There were some target problems that marred the tests in this period however three successful target intercepts were achieved between 2006 and 2008. In the 2005 to 2010 period I spent considerable time in Colorado Springs supporting the various flight tests. This was both interesting and difficult. This is the primary test control center so the work there was interesting. This was not particularly difficult as it was primarily to observe and comment if things didn't appear quite right, as well as to provide an opinion on the readiness for each mission. The difficult part was a long and somewhat dangerous drive from the hotel to the Air Force Base (AFB) followed by a processing through numerous security checkpoints at the development test facility. Occasionally bad weather would prevent travel and delay the whole operation or security issue would delay all entry or exit until resolved.

In the 2010 to 2013 period some serious technical issues showed up in three flight tests (FTG-06; FTG-06a; FTG-07). All three were different exoatmospheric kill vehicle (EKV) problems. Facing these difficulties, I shifted my main support to Raytheon at Tucson, AZ. This was very hard work as these were difficult technical problems. For about three years my work schedule was as follows: Monday work at home or Huntington Beach until midafternoon, then take the 5:30 PM flight to Tucson and get a hotel room near the Tucson airport. Work Tuesday, Wednesday and Thursday till midafternoon at Raytheon, then take the 5 PM flight back to home in Orange County. Work at Huntington Beach on Friday. Sometimes instead of going home on Thursday night I would drive up to Woodland Hills from the OC airport and work at Northrup Grumman on Friday and then return home from there. On the weekend I would try to get a little rest and do it all over again the next week. I wrote an e-mail report on the engineering teams' work every day.

In all my previous experience I had never had three flight failures sequentially. I have to say that the second two of these EKV failures were unlike anything anyone had ever experienced before. The engineers were using all their combined mental capacity to find the answers and figure out what to do about it. This was absolutely at technologies cutting edge. We just had to find the way out of these difficulties and there was no easy path. We had to break down the barriers and even make our own light at the end of the dark tunnel we were in. However, the strong wills and combined brain power of the engineering team did finally prevail.

The technical solutions were of course included in the following EKV's and they flew to three successful target intercepts in the period from June 2014 to March 2019. I was out of commission due to a stroke for the first of these three however I was able to support the latter two missions. As I think of this now, I know that being involved in solving these GMD EKV problems was truly the crowning achievement of my long career in aerospace. I am so satisfied that it all ended well.

Chapter 29: The Stroke - 2014

I wondered if I should include this but since it happened, I feel I should. My stroke occurred May 2014 when I was 79 years old.

I was working with the GMD team toward the readiness for the FTG-06b mission which incorporated the EKV changes to correct the previous flight failures. I was in Huntsville for a mission readiness review at MDA which was completed Wednesday at noon. I decided I would catch a flight back to California that afternoon. There was to be a meeting with the MDA Director the following day, but I felt I could attend that by classified video teleconference (CVTC) from Huntington Beach.

So, following this plan I went to the Huntsville airport to catch a midafternoon flight. At the Huntsville airport I learned that my flights had been cancelled due to weather problems. I am pretty sure my blood pressure went sky high on hearing this. Things were bad but I started looking into what I should do. Before long the airline agent told me they could get me on a later connection in Dallas into LAX. I figured this would be ok and I could take a taxi back to Newport Beach. It would be late but at least I would get home. That is what I did.

On the way from Huntsville to Dallas I wrote my report and sent it out as soon as I got to Dallas. The connection in Dallas was ok so I did not think anything more out of the ordinary was going to happen. But I was way wrong on that. On the Dallas to LAX flight I tried to sleep but I think I was still too keyed up and did not. On arriving at LAX I had trouble getting my luggage out of the overhead and sort of stumbled getting down the aisle. I got off the plane, but people probably thought I was drunk. In any case no one including me thought I had suffered a stroke. I felt tired but reasonably normal at this point. I made my way down to the taxi level without much difficulty. I found a taxi and we left for Newport Beach. On reaching home I stumbled a bit getting out of the taxi and dropped my credit cards but that was quickly resolved, and I went into my house. Eileen was asleep so I did not bother her but simply set the alarm and went to bed. I still did not know anything was wrong.

Early the next morning I got up, took a shower, dressed, ate breakfast and drove my car the 18 miles to Boeing Huntington Beach for the planned MDA CVTC meeting. When I got to the building entry door I stumbled and one of the engineers helped me get to the elevator. I still did not think anything was wrong, but others recognized that something was. I will be forever grateful to everyone in

Huntington Beach who helped me. They called the paramedics and within minutes I was on my way to the hospital. At the hospital Kevin and Charlotte caught up with me and the doctors started doing some tests. They pretty quickly knew I had suffered a stroke, but it was too late to do anything to reduce the severity. By that evening they moved me to the rehab hospital where I would spend the next three weeks. By that night my whole left side was paralyzed. I could not move my left arm or left leg at all.

Over the next three weeks I followed the rehabilitation routine and things started to very slowly improve. First it was only to move a finger, then move the left hand, then the left arm, then the left leg. Eventually I was able to walk using a walker. Fortunately, through all of this I did not lose any memory, reasoning ability, speech or eyesight. I appreciated visits from many of my work colleagues and my family; all who supported me throughout the recovery process. After three weeks I was able to go home and continue physical therapy there. That was followed by about two months of physical therapy at a nearby facility. Things slowly continued to improve, I was able to drive a car again and after several months I was able to return to work.

This was all a pretty tough time, but I had a lot of help from my family and eventually got most of my capabilities back. However, I still have difficulty walking and usually use a cane for assistance. But I am thankful nothing changed mentally, I can speak ok, I can drive, and I was able to return to work to support the last two successful GMD flight test missions. I feel I dodged a bullet. During the rehabilitation period I was tested by many specialist doctors and now take certain medications to help with conditions of age such as blood pressure, blood flow, etc. I had an artery stent put in before the artery restriction caused a heart attack. I now get regular heart tests and all is well. So, all in all I think I am now better off than I might have been without the stroke. Just a guess of course but I think a pretty good one.

Chapter 30: Second retirement 2019 ——?

I retired from my executive position at Boeing in January 1998 - completing a career of 41+ years. Subsequently later in 1998 I restarted work as an Aerospace engineering consultant. Most of this period to 2019 was spent on the GMD program. The culmination of my GMD work occurred in March 2019 with the FTG-11 flight test. FTG-11 was a full operational test of the GMD system against a mock intercontinental ballistic missile target re-entry vehicle (ICBM RV) heading toward the USA. Two interceptors were fired by the war fighters just as they would do in a real attack. The entire system worked perfectly. The target was intercepted (negated) by the first interceptor kill vehicle while the second interceptor was able to observe the impact and record data. It would have intercepted the target if the first interceptor had missed.

I was able to support the GMD program at VAFB throughout the two weeks leading up to this event and be in the VAFB mission support center to observe the data real time during this historic event. It was a resounding success by all measures. I was so happy to have been able to be a part of it. This was the best possible way to finish my career. Putting it all together I had now completed about 63 years in aerospace.

Later in May 2019 the GMD leadership joined together to give me and my family a very nice final retirement dinner at a restaurant in Newport Beach harbor. Norm Tew presented me a very nice plaque depicting the GMD mission of protecting our Nation 24/7 and the six successful flight tests from 2006 to 2019 with a citation that said: “Chuck Ordahl In recognition of your years of service on the GMD Program for the defense of the U. S. against ballistic missiles”. Everyone gave very nice speeches about working with me on GMD and how we got the objectives achieved. At the end I believed I had made a difference and for that I was very thankful.

I began my career in 1956 as a young engineer working on a team developing the Nation’s first strategic ballistic missile (Thor) and I ended my career working on a team developing GMD which now stands tall in defense of the Nation against a ballistic missile threat from an adversary. There were a lot of other things between, but these are two good bookends and I think I will leave it at that.



When I was presented this this plaque, they said “On behalf of a grateful nation, millions of Americans can sleep better tonight because of your efforts.” I was quite proud.



My second “retirement” celebration, Newport Beach 2019

Chapter 31: Looking to the Future

I have to say I was born at a good time (low birth rates during the great depression) and in a good North Dakota community (strong people that believed in working together). My parents assured I got a good education through Grafton High School and the University of North Dakota. Together all of these factors formed the foundation for a successful career and family life. I was fortunate to have found a wonderful wife (born and raised in ND) that shares my same values. We were successful in raising two fine children - a girl and a boy who both ended up working at McDonnell Douglas/Boeing. As time went on there are now four grandchildren - two girls and two boys. I was fortunate to join the right Company (Douglas Aircraft) at the right time (beginning of the missiles and space age).

Even with all these factors in my favor I still found it necessary to work very hard with a goal driven mindset for everything I achieved. But at every turn in the path of this life and career I found extremely intelligent and capable people that were willing and able to help me achieve these goals. For the most part I have to say that I accomplished very little on my own, but I can proudly say a lot was accomplished by the help of so many others that pitched in to do much of the heavy lifting. And first and foremost, almost none of this would have been possible without the help of my dear wife and partner Eileen. She cared for the children and provided the home environment that allowed me to flourish in the work environment. Thank you, Eileen.

Of course, although this is all in the past, it sets a context for the rest of this life. Eileen and I often talk about the many interesting and exciting experiences we have through work, family and travel. From the standpoint of travel, we are glad we did it when we did. We were young enough to do it with vigor and vitality but now the realities of age have set in and we know we have to stay much closer to home.

But our home is in fact three homes within easy driving distances. The place at Newport Beach has a view across all of Orange County from the ocean to the mountains with a fine yard for the roses, tomato and other plants that Eileen loves and cares for so well. It is also close to the Oasis Senior Center for classes and the gym. The place at Lake Arrowhead has a great view of the lake and the mountains beyond. It also has a dock at a location in Emerald Bay where the fishing is good and passing boat traffic is always interesting. The condo at San Diego on Mission Bay is right on the board walk and beach. The view is fantastic. Both Eileen and I enjoy just watching the many people walking their dogs and playing on the water

and on the beach. We walk a little on the boardwalk but not much anymore. All of our family continues to live close by, so we see them often. Another important factor now is that good medical facilities are close by.

We know and expect our life will be much slower going forward but that is ok - we have had our time.

Thank you for reading this life story.

Chuck Ordahl

Appendix of additional photos:

Family Photos



Baby Charles



Me and my sister Susan as children



Me and my sister Susan as young adults.



Family photo



High School graduation photo, 1952.



*Grandfather August Peterson, me and my dad, Oscar Ordahl,
(in front of my 1950 Pontiac on the left.)*



Eileen near her nursing school, 1957.



Leaving for our honeymoon.



Eileen in London, 1959



Dressed for church.



Visiting with Eileen's and my mother after returning from England.



Our first home as purchased in 1960, Canoga Park, California.



Ken Francis' "houseboat" on Lake Mead, Charlotte in the water



My mother, Eileen's mother, Eileen and myself at our Port Provence house



Eileen, Kevin and Charlotte Canoga Park, 1966.



One summer we kept our boat at Big Bear lake about a 45 minute drive from our cabin in Running Springs.



Our family, around 1968



*Relaxing in Mission Bay San Diego.
Perhaps the red wine made me sleepy.*



One of many black tie dinners and galas we attended.



Enjoying Newport Harbor



Charlotte, Kevin, Eileen and myself



Our Children and grandchildren



Charlotte married Tim in November of 1985



Kevin married Peaches in July of 1997.

Work Photos



Examples of some of my badges over the years.



Eileen and I chatting with Bob Johnson in Washington DC



Talking with Bill Schindler in Washington DC.



Commemorative launch patch



Over the years several Star Trek movies and a Kevin Costner movie, Waterworld, were made at the Huntington Beach site.



Signed autograph from Kevin Costner



Examining the PAM with astronaut Sally Ride.



To this day Eileen still has almost all the letters I wrote to her.