ORAL HISTORY: Lou Meren

About Lou Meren

Lou Meren was born in West Wyoming, Pennsylvania in 1931. After graduating from high school, Meren joined the Navy and served four years during the Korean War. While serving in the Navy, Meren decided he wanted to be an engineer, and after leaving the military he attended the University of Scranton for two years before transferring to the University of Detroit, where he earned his bachelor's degree in electrical engineering. In 1957, Meren began his long career at Westinghouse, starting as an associate engineer in Missile Ground Control. He was later transferred to the Electronics Division where he spent most of career. Over the course of nearly 40 years, Meren was promoted through management – he was supervisor, project engineer, engineering manager, design supervisor – and was in charge of various divisions and sections, including Power Generation Section manager (1974), Equipment Design Engineering Department manager (1978), Tactical Radars engineering manager, Surveillance Radar Division engineering manager (1982), Westinghouse Airships, Incorporated President (early 1990s), and CCCI&M Division chief engineer. He worked on many important projects while at Westinghouse such as BOMARC, Deep Submergence Systems, FAA Scan Converter, ARSR-3/ARSR-4, Hawk Digital Processor, TPS-70 and NAAWS. Meren retired from Westinghouse in 1994.

In this interview, Meren gives in-depth detail about his career at Westinghouse. He discusses his time in the military, his decision to become an engineer, and the draw of Westinghouse because it was 'heavily oriented toward electronics.' Meren talks about the many projects he was involved in over the years, the process of proposing and bidding for projects, and the successes and failures involved. Issues of design and working with customers – such as the FAA or military – are also covered, as are competition with other companies like GE, and cooperation with others like McDonnell Douglas. Meren also discusses his extensive international travel during his career – working with nations such as Taiwan, Israel, Spain, Germany, Korea, Mexico, Egypt, Chile and Finland – and the complexities involved with globally promoting Westinghouse products like airships and the TPS-70. He also talks about his management style, re-organizations within the company, and the importance of the people he worked with during his career such as Tom Tomlinson, Ted Foster, Wally Hoff, Coleman Miller and Milt Borkowski.

About the Interview

LOU MEREN: An Interview Conducted by Sheldon Hochheiser, IEEE History Center, 12 April 2010

Interview #536 for the National Electronics Museum and IEEE History Center, The Institute of Electrical and Electronic Engineers Inc.

Copyright Statement

It is recommended that this oral history be cited as follows:

Lou Meren, an oral history conducted in 2010 by Sheldon Hochheiser, IEEE History Center, New Brunswick, NJ USA at the National Electronics Museum, Linthicum, MD, USA

Interview

Interview: Lou Meren

Interviewer: Sheldon Hochheiser

Date: 12 April 2010

Location: The National Electronics Museum, Baltimore, Maryland

Background and Navy

Hochheiser:

This is Sheldon Hochheiser, [from] the IEEE History Center. It is the 12th of April, 2010. I'm here at the National Electronics Museum in Baltimore with Lou Meren to talk about his career with Westinghouse in Baltimore.

Meren:

Good afternoon.

Hochheiser:

We could start with a little background. When and where were you born?

Meren:

I was born in West Wyoming, PA on St. Patrick's Day, March 17th, 1931. We moved to Freeland, PA when I was about six months old to a house on about five acres at the end of town. My mother's parents lived with us and they grew vegetables, raised chickens and had a cow, just as they did in Switzerland before they emigrated to the USA. My father emigrated from the Italian Island of Sardinia so I'm a first generation American. My father was killed in a coal mining accident on September 2, 1941, just three months before Pearl Harbor.

Hochheiser:

Your father was a coal miner?

Meren:

Yes. We were a very close-knit family and his death was a terrible blow. My mother really worked hard to keep us going. When I was eleven, my friends and I were playing one night and I knelt down on the neck of a broken milk bottle. I suffered a cut under my knee which chipped off a part of my kneecap. It took a lot of stitches and months of rehab after it healed which my grandmother took care of. My mother reminded me that my father wanted me to learn to play the trumpet so I did that. In early 1943 my mother remarried and we moved to Plains, PA. My step-father owned a small grocery store which I worked in every day. Since there was still concern about my knee, my athletics were confined to sandlot sports. I auditioned for the school band by playing the "Star Spangled Banner" well enough to be awarded the first chair. From that position I was

asked to play “Taps” at the funerals for returning KIAs [Killed in Action], many of whom I knew. I always played the echo and an American Legionnaire played “Taps” at graveside, except once when I was alone for the funeral of a returned twin. I told myself that I would not cry after my father’s death, but I played through tears when I saw his mother at graveside. That’s when I knew I would join the Marines as soon as I could. However, my best friend asked me to join the Navy along with him and seven other guys he had already convinced. Ironically, he and three others flunked their physicals but all were drafted when the Korean War started. I had to perform extra exercises for two Navy doctors when they saw the scar under my knee. So here I was, barely 17 years old, a month out of high school and in the US Navy.

Hochheiser:

Were you interested in technology and science growing up?

Meren:

Not very much. But I was interested in how things worked. My mother said I probably wanted to be an engineer the time I stuck a coat hanger in a light socket. I was about six at the time and I knocked myself off a crate that I had put on a chair. I wanted [to] know what made the light on our back porch go on. And when I was even younger than that I took apart my grandfather's watch. He had a big musical Swiss watch. And I didn't quite get it back together. But no, I didn't decide I wanted to be an engineer until I was in the Navy.

Hochheiser:

What happened in the Navy to make you decide you wanted to be an engineer?

Meren:

A few things. One guy in my section on my aircraft carrier often bragged that he had a couple of years of engineering. I thought he was an airhead, devoid of common sense, and he often proved it. Once he tested the automatic fire system without learning about it and without prior authorization. When he activated it a motor drove a valve and water came down to put out the fire. This time there was no fire and he didn't know how to bypass the valve - when the saltwater came down it filled the cockpit of one of our fighter aircraft. The plane was beyond repair and had to be dumped over the side. Fortunately it was a hangar queen and the only plane on the hangar deck at the time. Incidentally, the plane was a Marine Corsair of the Black Sheep Squadron of World War

II fame. Col. Pappy Boyington was the original squadron commander. Our squadron commander was KIA during a close ground support mission during the early part of the Korean War. We also lost several other planes, pilots and support personnel. But this guy who had two years of engineering school should have known better. I don't know what they ever did to him. That was the first time I thought of becoming an engineer. On two other occasions I was so close when two people were killed that their blood splattered on me. I just wanted to be somewhere else, doing something else. After the second event I thought of becoming a doctor. But that quickly passed.

Hochheiser:

Yes.

Meren:

After my carrier duty I was transferred to a destroyer escort. All of the Electrician's Mates wanted that destroyer escort duty. So we put our dog tags in a hat and mine got picked. That's one of the few things I ever won. And [Chuckling] we wanted to go because we were told that this was a diesel-driven destroyer escort that needed a lot of electricians, but mostly because it was going to be running up and down the West Coast between San Diego and Bremerton, training reserves. So everybody qualified really wanted that duty. One of my shipmates and I had bought a convertible in San Diego. When we made our quick departure to Korea when the war started, we had to block it up and leave it on base. I really looked forward to every sailor's California dream - liberty again - which included a convertible.

Hochheiser:

Sure.

Meren:

I flew out of Kimpo Airfield in Seoul, Korea on a C-119 cargo plane. We island-hopped across the Pacific then base-hopped to DC where I caught a bus home for a two week leave. When I left Seoul, it was in ruins. Nothing was standing except the piles of rubble. When I got back there in 1982, I was in the middle of a really spectacular city. After my leave, I flew to San Diego to my new ship. She was actually a steam-driven vessel. Therefore we had an over-complement of Electrician's Mates. And I was the senior petty officer aboard. But rather than running up and down the West Coast, we took her out of mothballs, and had her shakedown cruise on the way to Pearl Harbor. We arrived on the

day that I was supposed to have been discharged. My three year enlistment was up but it was extended for a year. They called that the Truman year. And that pretty much turned out to be [Chuckling] the worst year of my life. We headed back to Korea and on the way we rewound every motor on the ship. I started thinking about college again and of becoming an engineer. Two years earlier while I was going to EM School at Great Lakes I passed an exam for pilot training. I packed my seabag and was waiting to board the plane for Corpus Christi when a jeep with a Lt. Commander and a sailor with his seabag in it came roaring up to us. The LCDR asked me how old I was and when I said 17 he told the new guy to take my place. On the way back to the barracks he told me that I had to be over 18 to go. When I got back my classmates said I owed them a party but they were happy to see me back. The following year I passed the exam for the Naval Academy but didn't make the cut. I forgot college for a long time after those disappointments. But I got more interested in electricity and electronics. Soon I was on my second Korean tour, this time in Wonsan Harbor. One day I was smoking a cigarette on the torpedo deck and saw a splash. I turned around and saw a couple of flashes from the mountains behind me. Then General Quarters sounded. As I was running to my battle station I said to myself, "what in the blank am I doing here?" And that's precisely when I decided what I wanted to be now that I was grown up.

Hochheiser:

Right.

Meren:

I was a radar gun pointer on that tin can. But we were never attacked by aircraft so all of our firing was confined to targets on shore or on the water and most was done manually. One early problem occurred with an electrical controller whose components were mounted on a large bakelite base. When we fired our five-inch gun rapidly it would crack right down the middle and after a few rounds that failure would put the laundry out of commission. And that ticked everybody off. We didn't have any spares so I devised a brace and shock-mounted insulated brackets and actually fixed the problem which made everybody happy. The GE logo was in the housing. [Chuckling] So I didn't like GE very much.

Hochheiser:

So you got out of the Navy after four years.

Meren:

Yes.

Education

Hochheiser:

And then you went to school?

Meren:

Yes. After about three months of wild celebration, I started at the University of Scranton.

Hochheiser:

Right, which is in the part of Pennsylvania you were from -

Meren:

Yes, just north of Plains. I had saved money, some from winning at poker aboard ship, and luckily PA was one of the few states which paid a bonus to Korean veterans plus an additional 100 dollars a month for each month in combat. So with letters from my COs, 17 of my 24 months in and around Korea qualified me to receive a much needed 1700 dollars. I spent two years there in pre-engineering. I forgot that you couldn't transfer to the University of Detroit with less than a 3.0 average. Both of these are Jesuit universities and were very tough, especially after being out of high school for over four years. I was goofing around a little in college. Six of us who were veterans were classmates. We'd stop off and have a few beers between classes. We were going to school with kids just out of high school and we didn't want to corrupt them so we wouldn't take them into any bars with us even though [they] always asked. Besides them being underage, the Jesuits would have skinned us. We managed to get through our first two years but I'm the only one of the six who eventually earned an engineering degree.

Hochheiser:

And you were able then to transfer to the University of Detroit?

Meren:

Yes. I got engaged before I left and I had to take a few summer courses, but I built up my marks enough to qualify for the Electrical Engineering Honor Society, Eta Kappa Nu. It was pretty much a struggle after that, primarily due to money concerns. The GI Bill provided only 90 dollars a month which paid a small part of my tuition. The U of Detroit was a co-op school so I alternatively worked for three months and I went to school for three months. I was earning money but not enough. Loans, including one from my sister, made up the difference. So when I got out of school I was in hock up to my eyeballs.

Going to Westinghouse, BOMARC

Hochheiser:

And what led you from the University of Detroit to Westinghouse rather than some other opportunity?

Meren:

Westinghouse sent interviewers to the campus. I was convinced that I wanted to work for a company that provided electronics equipment for the Navy. I had worked for a power company as a co-op through my three years at Detroit. When I graduated the CEO of the Pennsylvania Power and Light Company where I was working said he wanted me to come to work for them. I said, the way I see it you have an engineering manager in each division. The only time I could get to do anything relative to electronics is when somebody died or retired. Because you couldn't upgrade a substation until the people working there, who were union people, retired or got another job. And I said I wanted to work in some place that was heavily oriented toward electronics. So I interviewed Westinghouse. My sister worked for Dupont and I knew it was a great company so I interviewed [with] them. Also, I'd taken some graduate courses in nuclear engineering. After the interview I didn't think I wanted to be a nuclear engineer. I also interviewed [with] Philco. Most of their work seemed to be TV related and I had had enough TV. My undergraduate thesis had been a demonstrator TV. Years ago, when they were teaching radio, the teachers had the components laid out above the schematic. One of the engineering professors wanted a TV demonstrator with its components laid out over its schematic. My two roommates and I decided we would do it. It turned out to be quite a tussle because frequencies are so much higher. We had built it on a wooden platform that we could tip up so that we could see both sides. We finally got it working when we discovered that we needed a little more distributed capacitance at some points. We could do anything we wanted to under the box as long as we didn't add components above. We finally came up with a good grounding system and took care of the

distributed capacitance and got it working. And the first paper that I participated in publishing was our thesis. Because we did an undergraduate thesis the degree I have is a BEE as opposed to a BSEE. And other than that my college career was quite uneventful. But I decided to work for Westinghouse and I never regretted it.

Hochheiser:

Right.

Meren:

I was interviewed in a Quonset hut at Wilkens Avenue where our torpedoes were designed.

Hochheiser:

So they brought you here to Baltimore for the interview.

Meren:

Yes. But I wasn't interviewed in the building where I was going to be working. That was our Parker Road facility. The interviewer came to the Quonset hut and described what they were doing there. It was the Missile Ground Control Engineering Department.

Hochheiser:

Okay. So that's the department that you were hired into.

Meren:

Right.

Hochheiser:

So you started there in '57?

Meren:

Right.

Hochheiser:

I guess as an associate engineer.

Meren:

Exactly.

Hochheiser:

Which I guess was the standard starting spot.

Meren:

Absolutely. That's as low as you can get on the engineering totem pole. That was the entry level engineering position.

Hochheiser:

Right.

Meren:

On my first day I was introduced to the people I'd be working for. My first supervisor was George Martin. My project engineer was George Henry. George and I chatted a few minutes and he said we have a problem that's been plaguing us. He said it's in the missile flight simulator for the BOMARC. And he said I'll take you out and show it to you in a minute, so I'd just like you to read over the documentation and familiarize yourself with the hardware. We've been fighting this problem for over six weeks. We walked out to the lab and he showed me the simulator which was housed in two cabinets. It included feedback amplifiers driving gear trains and the output of this was, as the name implied, simulation of the flight of a BOMARC missile. When George turned it on the gears started chattering and he turned it off quickly. He said that's the problem. He said we have all these individual loops and they all work in and of themselves but when we close the whole loop around the system these gears are chattering. He asked, do you know what is causing that? I said yes, you've got positive feedback someplace. I had just finished a course which covered servo mechanisms and Bode plots and feedback amplifiers. He said okay. So I studied for a couple of days and then I said to him, have your guys undone all of the loops and tried to individually test them? He said, yes we've done all that. I said well do you mind if I do that just to get caught up to where you are?

He said no it's fairly straightforward you can see how everything is hooked up here. On my fourth day I started taking loops down. I'd load them and sure enough every one of them worked independently. I had worked until lunchtime. I kept working through my lunch hour. About 12:15, one of the loops that I had loaded was on and it was working. I turned around to have a drink at the water fountain right behind me. Then I walked back past the cabinet to look at some documentation. While I was standing there I heard a 'pow' and right where I had been drinking there was a brown spot of tar. One of the output transformers in a chassis blew its potting cap off. And [Chuckling] I said well I know what the problem is. That's the one that's oscillating. A technician and a janitor ran over to see if I was okay. They cleaned up the mess while I got a spare transformer. After the tech put it in, I reconnected everything and turned it on. It started to operate . All of the gears were turning and nothing chattered. I turned it off. Lunch time was over and I walked in and I said to George Henry, I think I have it working. And he said what? [Chuckling] And I said yeah. So we went out to the lab. He turned it on and it played its tune. And his jaw dropped. When he said what did you do and I told him he said well we did all that. I said yeah but I think maybe you didn't do it long enough. I said I had this one chassis on long enough that this transformer heated up and blew off its cap.

Hochheiser:

Yes.

Meren:

I got the shop to cut apart the transformer and found an internal wiring error, two leads were reversed. That caused the positive feedback. As soon as the story got around people were amazed that I had figured out what was wrong after just four days with the company. Before that went too far, I told George and others in the group that it was just a lucky call. He said Lou, whatever it was we got this thing working and we're getting back on schedule. After a while the guys were testing me. Larry Nix who is one of the best engineers I've known would ask me to run a Bode plot for him or to review some amplifier and I would. I thought wow, this guy must think I'm some kind of a threat to him. Meanwhile, I knew very quickly that I would have to work very hard if I ever hoped to catch up to these guys.

Hochheiser:

Right.

Meren:

Most 26 year olds had been in engineering for five years so they were engineers and senior engineers. And most associate engineers were 21 years old.

Hochheiser:

Straight out of high school or college.

Meren:

Exactly. I knew I was more mature than some of these guys but I was an anomaly. And I was the only Korean vet in that whole outfit. I was only there for two weeks when I asked for a week off so I could graduate. I drove to Detroit with my fiancée and both our mothers.

Hochheiser:

Yes.

Meren:

Three weeks later I asked for a week off to get married. And they were very nice and even paid me for that and I thought wow this is just great. When I came back I worked for three months. Then I was in an automobile accident. A 16 year old drunk T-boned me and almost destroyed me. I spent a week in a VA hospital in PA where the accident had occurred. I came back to work for three months from the end of September until December but the pain was unbearable. I had to take a month off to rehab my left side, which was injured when I flew out of the car. I was put on disability. When I came back, I had to check in with the nurse. She said we're going to have a layoff. The word is out. And with all the time you've missed, I don't think you're going to be around here. The nurse, Jean, and her husband Bill Grennon were from a hometown very close to our hometown and her husband worked down the hall as a senior engineer.

Hochheiser:

Right.

Meren:

When I went home I told my wife that we might be getting some bad news. But the fact is I didn't get laid off. I was very grateful to Westinghouse for their belief in me and the trust they placed in me and I figured I was going to pay them back. I talked it over with my wife and told her that I would do whatever job I was assigned and never ask for a raise, promotion or a transfer. It was going to be like an extension of my navy career except with more freedom and more money. I also knew that I could get by with very little sleep which I was forced to do at times in the Navy. So in case I had to study at night to catch up with the design engineers, I knew that I could do it. I had told my wife before our marriage that I would be the moneymaker and she would be the homemaker and retired her to her new position after our wedding. She had sacrificed college and had worked hard to support her mother and three younger brothers for nearly ten years and had really earned it.

Hochheiser:

Right.

Meren:

After our initial work, we got the contract for the improved BOMARC Ground Control System. For the first several months I was working on the first system, the XW-1. Then we booked the XW-3. That was the operational BOMARC system.

Hochheiser:

Right.

Meren:

Prior to that I had been working with the engineers testing the equipment they had designed, the display consoles for both the Direction and the Tracking Stations. All of the equipment was analog and, since this was the pre-transistor era, designed with tubes. The manual rate-aided track function was performed via a track ball, in this case a bowling ball which drove two precision potentiometers. The operational amplifiers required for tracking were designed by Larry Nix. I was helping him test them and quickly found out what a brilliant engineer he was. During this time I designed my first circuit, which was an astable multi-vibrator. It was used to blink alarm lights on the consoles and blinked at 3 or 6 times per second. I was really happy that I did this all by myself and got it through all of its reviews successfully. John Boykin, who reviewed all designs, congratulated me. Later as we were testing one of the consoles I walked behind

it to monitor a signal and saw a rear end sticking out of the back door. This person had his head and shoulders inside of the back of the console. I was amazed. I reached in and grabbed him by the belt and flung him out on the floor. I said what's wrong with you blah, blah, blah. I noticed he wore a red badge identifying him as a Field Service Engineer. And I said what are you doing inside all of the safety barriers we have here? You're lucky you didn't get your ears fried. The power is on and you had your head very close to 16 KV. After that event we spent half a day convincing our Safety and Security people that we knew how to isolate our test area and lock out unauthorized personnel.

Hochheiser:

Hum. And in the meantime, I'm sorry, did I interrupt you?

Meren:

No. But all of that was part of the first system. Then we began the second system.

Hochheiser:

Right.

Meren:

My new Project Engineer was Charlie Saunders. My assignment was to design a linear video amplifier for the missile's Beacon Decoder using miniature vacuum tubes. The transponder squawked a special code when interrogated. I designed and built a model of the circuit and started testing it in the lab. Things looked very good to me. I had hooked up a test equipment which generated any code I set. I was playing a code through the amplifier and had an oscilloscope on its output. I asked Charlie to review it. He told me it looked good. Then my real education as a design engineer began. He told me that now we needed to find out how it behaved when it was stressed by temperature, humidity and power source variations. He showed me where to find the limits for compliance and had me find out how to prepare documentation for my requirements, the design and test specs. For the next two weeks he spent about an hour a day nursing me through all of the changes I had to make to meet all of the amplifier's requirements. Then it was ready. I took my design spec to drafting and left. The next day I found it back on my desk with a note from the drafting supervisor. When I talked to him he said the draftsman said it was lacking some details. So I took it to him and asked if he would show me what was lacking so I could make future D-specs more acceptable. He said in the past when he kicked specs back the engineers would get other engineers

to help and that I was the first one to ever ask him. I told him to think of me as a sponge. I soak up good information from wherever I find it. Then since no new engineers showed up, I was assigned the rest of the decoder to design. When I finished that I designed a chassis which housed three Beacon Decoders. By this time the program had developed a set of standard power supplies, cabinets and a set of standard transistorized digital printed circuit cards. Now George Martin talked to me about designing the logic between the request for the missile, its launch, tracking and kill evaluation.

Hochheiser:

Is this coming along quickly or about when was this?

Meren:

This was '58, '59.

Hochheiser:

Okay. So this was all within a period of a couple of years.

Meren:

Yes, We were waiting for more engineers but George wanted me to learn Boolean algebra and logic design. I learned how to do that very quickly from a really great engineer, Sam Zimmerman. He was a digital expert who taught design at the Westinghouse School of Engineering Sciences. I had asked Sam to periodically review my designs for me and he taught me what I needed to know about clock speeds, sneak paths and other design subtleties. Don Scott was his manager. Don's group designed the standard family of printed circuit cards. One card had two flip-flops on it. Other cards had as many multiple input and or gates as pin limitations would allow. These were the building blocks for all digital logic design for this program. Next I got to sit in on meetings with our system architects and documented the requirements for the design I was about to begin. Now I was exposed to three outstanding engineers, Jim Clark, Maury Wexler and John Gitt. When they finished passing down the requirements I started designing what really was a hard-wired, fixed program computer. We drew our own diagrams using logic symbol templates and we printed our own running lists. When I finished, the design consisted of over 450 cards. Each card had a 23 pin connector with 2 pins devoted to power and ground. I don't recall whether a pin could hold 2 or 3 wires, but in total the chassis had over 10,500 connections all of which were manually

entered on long lists. I knew that they were destined for typists but my concern about transcription errors prevented that from happening. The chassis was hand wired since numerically controlled machines were not yet available.

Hochheiser:

Sure.

Meren:

This was a horrendous amount of work. I used to take the logic diagrams home with me. I wanted to spend my time at work designing so I taught my wife how to read them and she and I made up the running lists for those 450 cards worth of logic. I [Chuckling] convinced her when I said what the heck, we don't have much to do anyway. We didn't have much money left after paying our bills. So she jumped right into it. In fact, after a while I thought she wanted to start designing something by herself. She turned out to be my secret weapon. She was remarkable. Due to our work at home my running lists kept pace with my design. When I finished the design my wife and I double checked everything over a weekend. On Monday I took the logic diagrams and running lists to my weekly schedule review for sign-off. Reviews were held every Monday morning in my section manager's office. My section manager, Dave Balthis, was a stickler for detail and one of the finest people I have ever known. I worked in his section for my first 13 years at Wx. The pile of drawings which I was getting ready to release to the shop included those for the drawers that the cards plugged into and the cabinet that housed those drawers and the drawer containing the three Beacon Decoders which I had previously released to the shop. In fact, I had designed the entire cabinet that supported the Engagement Direction Station and everything in it . Later, as part of my test plan, I designed a control panel to test the cabinet. But I was asked to tailor it to fit into the console bullnose, and that became the control panel used by Joe Spontak to launch every BOMARC missile ever fired. Joe was a navigator shot down over Germany during WWII and spent time as a POW and is a longtime friend.

The wiring information on the running lists was months ahead of schedule. We released it to the shop and I wrote test specs for the hardware I had designed and visited the shop a few times a day to see how things were going. I got to know all of the shop people, some of whom were veterans. They got me to join the American Legion and the VFW and we sometimes joined them at dances and parties. When the hardware started coming out it was brought to a large laboratory area for testing. And it was all my hardware. The decoders went through their test very quickly and our configuration management group signed off on them. This meant that nothing could be changed

without authorization from Boeing or a letter from God, or so it seemed. I was anxious to start testing the logic I had designed. When the cabinet arrived, a technician circuit checked the wiring and smoke-tested the cabinet. It was fine and he mounted the drawers. But I was not going to circuit check the chassis with its thousands of connections except for the power and ground pins. I knew that the design was very forgiving so I decided to test the logic in the same order in which I had designed it. So I started on page one of my diagrams, plugged in the first card with the logic elements on it and checked for the proper outputs. It was unbelievable. In less than a week everything was tested. I had uncovered three errors. Two were wiring errors and one was an error which I had made by blocking a signal path by mistake. The cabinet was ready to support the Engagement Direction Station which was getting ready to come out of the shop. And [Chuckling] one engineer from another section approached me and he said you're making us all look bad. And [Chuckling] I said what? and he said yeah, you're doing the work of three or four engineers. I just ignored him. I told my wife what he said and she said I think we've paid Westinghouse back for how well you were treated when you started. [Chuckling] For years, usually at some elegant restaurant, especially when we travelled around Europe, she would say we've sure come a long way since we started at Westinghouse haven't we. That would always remind me how great a job I had and how special a wife I had.

Hochheiser:

Sure.

Meren:

I used to compare the feeling I got when something I designed was delivered with what I thought an obstetrician must feel like after delivering a baby.

Hochheiser:

So you've finished the design of the XW 3 for BOMARC.

Meren:

Right.

Hochheiser:

And then you moved onto another assignment?

Meren:

Right after we finished I was asked to go to Florida to check out the equipment that our section had designed. I was told that if I went, Charlie Saunders, George Henry, and others could stay at Parker Road and start up the Typhon Program. Just before I left I was asked to check out a cabinet designed in another section by Charlie Hills who had suffered a heart attack. Although his cabinet interfaced with mine I wasn't familiar with it. One of our system engineers, John Gitt, was taking it to the field. The field manager was Joe Spontak who I mentioned earlier. Our Air Arm Division provided the radar in the nose of the missile. And Boeing was the prime.

Hochheiser:

Okay. They did the missile. Air Arm did the radar.

Meren:

And we did all the ground control equipment. It was great for me to go to the field with the equipment. It was another learning experience. When I arrived in Florida, the first name I saw on a lawn sign on Eglin Air Force Base was that of Colonel Paul Tibbits who flew the Enola Gay. I met him when he toured the facility. The checkout of both equipments went well when they tested individually. But when they were connected together they were incompatible. Charlie's cabinet used mechanical switches, crossbars and relays to pass through missile requests and data and the logic in my equipment couldn't tolerate the switching transients. I quickly came up with a fix which I could implement by de-coupling a lot of signals. When I called Baltimore I was told that I couldn't do that to my configured equipment. I was told the same thing about Charlie's equipment. I joked with John Gitt and told him that since I couldn't modify either equipment I'd probably have to put something in between the cabinets in the cable trench under the platform. Two weeks later my joke became reality when I had the configured decoupling and filter unit I had quickly designed installed in the cable trench between the cabinets. The next evening our Department Manager, Maynard Briggs, flew down and after a short visit took John Gitt and I to dinner at the Kapok Tree Inn near Tampa. The next day I was home. While I was on site I met and worked with Fred Popodi who solved several difficult problems for us during my career.

Hochheiser:

Right.

ELF Computers and Transit Program

Meren:

Some of us transferred to the Electronics Division managed by Bob Kirby and located in the West Building where I spent most of my career. During my next assignment I designed a few analog and digital PC boards for the AN/UPA-48 Display for a contract to replace the tube type AN/UPA-35 PPI with transistorized circuitry. Next I was loaned to Advanced Development to interface a computer with a matrix display which was 64 by 128 elements. The Navy had contracted Maico, the hearing aid company, to design two digital computers. Each was to drive an electroluminescent ferroelectric, ELF, display being designed by the Wx Research Labs in Pittsburgh. For many reasons, the Navy cancelled the computer contract. The second computer was delivered to our Advanced Development Lab, and I was given three months to integrate it with the display. All existing documentation including logic diagrams and a draft copy of the instruction book along with spare boards, a tape punch and a paper tape reader used to program the computer were included. The design was incomplete. It lacked the ability to interface with the display. Fortunately, my training by those very sharp engineers I mentioned earlier brought success. I designed the output registers for the computer and a shift register which I planned to output to an oscilloscope. I needed to modify the scope to intensity modulate its CRT to couple the shift register output into its cathode. I was pretty sure that no one would give me permission to do that, so I just did it. Later, when there was a question about the source of a problem between the computer and the display, the answer was on the scope. I was well prepared to succeed at this assignment which I finished on time. Reed Brainerd, one of the Advanced Development Managers responsible for this project, was very grateful for what I had done. Somewhere along the line, for his first Wx job, Wally Hoff was assigned to this project.

Meanwhile, Ed Smith's Communications Section won the contract for the Navy's Transit Program, the AN/BRN-3 Receiver Set. The Applied Physics Lab of Johns Hopkins University was the Navy's prime contractor for the development phase. The equipment receives and decodes signals from transit navigational satellites and accurately establishes the position of our nuclear subs. That scenario and a receiver are in a gallery here in the National Electronics Museum. Dave Balthis agreed to help design the system. I was an acting supervisor and assigned Peyton Marshall as the project engineer. One requirement was to ensure the sub's captain that the equipment was operational before he exposed his periscope and antenna to receive the satellite's transmission. To accomplish this we designed an operational test equipment which simulated the satellite and injected an encoded signal into the front end of the receiver. This was a

difficult task. The signal had to emulate that received from the satellite, especially its stability. Our design included solid-state digital, analog and RF circuits. Once again we were able to reapply the digital PC cards developed for the BOMARC when we designed the Barker Word Generator section of the OTE. Ed asked me to write the parameters report which APL required. The stability of each circuit and subsystem had to be calculated then used in an overall mathematical evaluation of the system to confirm that the overall system stability was adequate to position the sub within a specified circle of accuracy. I knew how to analyze the circuits and how to describe the transfer functions throughout the system. But no one ever taught me how to combine all of the pieces until I had a few skull sessions with Les Thomas nearly always at lunchtime. He showed me which parameters added directly, and how some were the result of RMS combinations for example. Then I wrote the report. It seemed to me that every time I needed help some really great engineer would emerge. Les was one of those responsible for the success of the Transit Program.

Antenna Multi-Couplers

Hochheiser:

Was Typhon your next assignment?

Meren:

No. It was an antenna multi-coupler assignment. I was loaned to another group. When we moved, my section manager Dave Balthis and I and several other people went and he started the display and control group.

Hochheiser:

Okay. So you're working on displays then.

Meren:

Right. But we didn't have any display work to do. So I was loaned to a communications group for some work on HF antenna multi-couplers. I was supposed to be there for three months, reporting to Tom Frame, the group supervisor. He brought me quickly up to speed then took me out to the factory where several people were tuning the multi-couplers. The components were mounted on stand-offs wired together to form a chassis mounted assembly. A distributed amplifier was being designed to drive a number of those assemblies. Tom told me the test department was having trouble tuning the units

and had spent too many hours on the small pre-production lot he had shown me. He wanted me to see if I could find a way to shorten the test cycle. I took a schematic home with me and after dinner I sketched out a printed circuit card that could house all of the components. The next day I told Tom that I wanted to try a printed card solution for repeatability since all of the assemblies had been wired with subtle differences. He hadn't heard about our work at Parker Road so I told him about how we laid out our own breadboards before we had drafting make a set of manufacturing drawings. After lunch he told me to go ahead. Before that he had called Dave Balthis and Charlie Saunders to see whether or not I had my head screwed on right. He then held the release of further units. I laid out a card and showed some of his engineers how to do it. We quickly got four cards etched, built them up and had the test department tune them. They were all easy to tune and met the spec. Drafting was started. Tom said they could mount the circuit inside an aluminum can to shield it and that was done. So my assignment there only lasted two weeks because we had -

Hochheiser:

You solved the problem.

Meren:

Yes. But it was just an opportune time. I brought the printed circuit technology to a group that hadn't used it before. We had just finished a job where we did [use it], so it was an easy fit.

Display Group: Typhon, WIRDS

Hochheiser:

Okay. So then, did you go back to the display group?

Meren:

Yes. I spent 13 years in the display group.

Hochheiser:

I see that. So I guess probably somewhere around, what, '62 or so?

Meren:

Yes.

Hochheiser:

So now you're beginning to actually work on the displays.

Meren:

Yes. The first display for our group was the display for the AN/SPG-59 Typhon Radar Program. It was a combined selectable A, R, or Z display which was used to measure the contents of the Doppler filters among other things. Our interface for the program was George Henry. And very soon after that we got the go ahead to do the display for the Spade Sonar system which was a 1000 line monitor used to display the output of single-ended scan converters. Charlie Saunders was our interface for that program. Both worked for George Martin and knew my display capability because they had trained me. Because the designs were concurrent and both were Navy programs we found a lot of common requirements which we could take advantage of for the future. So I laid out project plans which resulted in a standard console design. By this time I had a group of engineers and -

Hochheiser:

So by this time you had worked your way up, engineer, senior engineer and now you were a project engineer?

Meren:

Right.

Hochheiser:

Right. So you have people now reporting to you.

Meren:

Yes. Really super people. Then, a program that Jack Spangler had won at Parker Road called WIRDS, the Weather Information Remoting and Display System, was transferred to our section and my assignment was to finish it up. A single-ended storage tube received weather radar data in its rho-theta or PPI format and converted it to a slow-

scan TV format and also compressed its bandwidth for transmission over ordinary telephone lines. It was a really clever modular design. Standard size plug-in modules housed a miniature scan converter and its control circuitry, power supplies and PC cards. The cards were about 2 by 3 inches. The modules plugged into a cabinet. To finish the design, Bob Fowler and I determined that we needed to design 25 additional PC card types. Bob took on twelve of them and I spread the rest among five other engineers. There wasn't much money left and we were not allowed to overrun the remaining budget. Sometimes when programs ran out of money you either had the opportunity to overrun or to spend unlimited amounts of your own time. Dave Balthis asked us to work many hours of free overtime. But to his credit, he was always there with us. All of us liked our jobs. We all felt that display design was the most glamorous part of engineering and the heart of every electronic system so we liked what we were doing. I told you earlier why I developed a sense of loyalty to Wx so nothing bothered me. And so we finished that job mostly on our own time hoping that we would get a follow-on production contract. But we never did. So the customer got a terrific bargain. But it added valuable scan converter technology to our section.

Hochheiser:

Now who was the customer for this system?

Meren:

The FAA.

Hochheiser:

So now you're not on a military project.

Navy ASW Radar

Meren:

Not until my next assignment as project engineer for the Navy ASW Radar. We designed a display console which included a high resolution PPI and a direct view storage tube which we used as an expanded PPI. The radar could detect a sub's periscope and we used that event to expand the area around the detection and cue the target coordinates to the ship's CIC and weapons systems. The Ka band radar for this system was provided by our Air Arm Division and modified for shipboard use by our radar engineers. Our program office booked derivatives of this radar, the BOSS and the SDR. The Navy used

the radar in their Broad Ocean Scoring System. The Air Force used the SDR radar for splash detection. When the Air Force launched a missile from Vandenberg AFB they wanted to retrieve the instrumented nose cone after it splashed down in the lagoon at Kwajalein. The time line required that we automatically positioned the EPPI display inside a 1/4 mile window. Translating that requirement to display terms meant we had to pulse the tube's cathode at 1500 volts for three microseconds on each range sweep within the azimuth gate. The manual positioning applications of the past permitted slower switching time. I had assigned Larry Nix, our most experienced design engineer, to the DVST's. He had been trying various ways to snap the cathode on and off but nothing worked. At the next Monday schedule review I told Dave Balthis that we had a problem we hadn't been able to solve. He said what will it take and I said probably an invention. Without batting an eye he said how long will that take and I said 6 weeks and that's what was reported to the program. I went out to the lab and told Larry that Dave had just scheduled an invention for us and he said well, we better get busy.

Usually our displays were the first subsystems to show up for system test. But now we were taking a lot of heat. We were going to blow the system's shipping schedule but more importantly we would miss a billing milestone. That got me a lot of unwanted help and attention. Immediately, Larry and I reviewed, discussed, tried and discarded a lot of potential solutions. We even asked our tube division about stuffing a switching tube or a spark gap or anything they could inside the tube but they couldn't or wouldn't. After a week Larry and I went into a quiet conference room and started reviewing everything we had ever done that we thought could help. At one point I said too bad we're not working at ground level where I could snap a flip-flop on and off fast enough. We soon got around to talking about floating a flip-flop at 1500 volts. Then Larry said he thought that coupling triggers through a light pipe would work. I felt we had our breakthrough. Larry designed an insulated box which contained the circuitry and the tube socket. We delivered the console to system test two weeks before other subsystems arrived. A missile launch occurred after the radar was fielded but before it was commissioned. We detected the splash and while we played back the recorded event we directed a boat carrying a diver to the spot. He retrieved the nose cone. The customer told us that the system had paid for itself before they had accepted it.

DSSP

In late '64 I was assigned to a proposal team headed by John Gitt. Wx was going to team with Chrysler and bid the Main Battle Tank, a joint USA-Federal Republic of Germany procurement. John asked me to architect the display and control sub-system. The tank included radar, sonar, TV and IR sensors. As usual, the proposal took a lot of effort, but Chrysler was very pleased with our input. It was required that we had a

number of engineers who spoke technical German and another number of engineers who could speak conversational German. John and I and others took a Berlitz course from 4 to 6 PM for a few weeks and learned the language. Soon after that, the customer wanted the bidders to re-submit new proposals and Chrysler, feeling that they lost, withdrew from the competition. This left us with a fine system but no platform to put it on. We were further disappointed when General Motors and their partner won. During that time, Jim Beggs had a call from the CEO of IBM. He wanted us to take responsibility for the digital display they were proposing for the FAA's Automated Air Traffic Control System. Their engineers had been unable to get a model working as required by the spec. If we agreed to help them they would also let us manufacture the display processor which they had designed, built and debugged. When we visited their lab we found that they really had six consoles, each evaluating a different subsystem within the display. Besides the significant effort they still had a long way to go. We learned a lot about how rigid their management was when designing computer systems and we thought that limited their engineers when they applied it to displays before they had a working unit.

We had the most advanced of the prototypes shipped to Baltimore along with one additional set of subsystems which we assembled into a single console for evaluation. We soon found that the deflection system was running out of gas and that the yoke needed to be redesigned to permit full-scale deflection as well as to provide improved linearity. IBM had requested more time but their request was denied. IBM withdrew their bid and once again we were left with a solution and no problem to solve. Soon after that, at 4 o'clock on a Friday, Dave B told me that John Gitt, who was now an Underseas Division Systems engineer, wanted me to define a display and control system for use on a project they were pursuing. He needed me at their division near Annapolis the following morning, Saturday at 8am. John held the meeting in a classified area and I got read in to the program. It was a very comprehensive multi-sensor search system. Some elements of it are here in the museum. And so I architected the display and control system which included a dual-display console, a computer control console and a platform control console. The widely divergent scan rates of the sensors required scan converters. Video and tape recorders were added to satisfy mission needs. A TV camera was required on the platform which was to be towed underwater at mission depth. All data was to be piped through a compressed bandwidth channel of the tow cable that ruled out conventional TV. So I defined the world's first slow-scan, low light level TV. Close to midnight that night, the seven of us who were involved finished our work. The next day, Sunday, we estimated the cost of the system and on Monday we got the go ahead to start a CPFF program with a 9 month delivery schedule. It became known as the Deep Submergence Systems Program, or DSSP.

Hochheiser:

About when was this?

Meren:

April of ‘65. By now the division had been reorganized. The four design sections for antenna, transmitter, receiver and signal processing and our display section reported through Guy Bias, who reported to Ben Vester and was matrixed to Hagan Jackson. George Martin now managed systems engineering and Tom Porter managed programs. Both reported to Jackson who reported to our new GM, Jim Beggs. All of the hardware that I had specified was booked through Jackson and I was named the engineering manager. I quickly decomposed the system and worked with the project engineers I assigned to the various pieces. Once again I asked Don Scott to design a family of digital PC cards. His starting point was a family he designed for us for a proposed display that the Navy never awarded. The new cards used integrated circuits inside TO-5 cans. They became our 330 series. Since I only had 11 engineers in my group, I had to borrow 20 engineers. I assigned the loanees to the project engineers. Each PE was responsible for the cost, schedule and performance of his piece. Dave B reviewed everything every Monday and that gave me much more time to oversee the design. I borrowed Lee Cole to do the digital design and assigned he and Darryl Braman to Bob Fowler who was responsible for the display console. After a couple of technical reviews I knew that they could design rings around me. Carl Cloninger had the scan converter and Burt Drummond, for his first project engineering assignment, had the film recorder. Maurice Hegwood, Bob Curry, Bernie Cataldo and Jan Kaminski had the computer control and platform control consoles and tape recorder cabinet and Gerry Schreiber did the LLLTV camera. Gerry and I met with Jeff Hamby who managed the lunar camera design section. He brought Larkin Niemeyer and Len Svenson into a meeting with us. We all soon agreed that the only commonality, again because of the scan rate, was in the SEC Vidicon that both cameras would use. When we got back I told Gerry to start the design. He never asked for help and designed it by himself. The camera slid into a cylinder thick enough to withstand the mission pressure and worked like a charm. It was a tremendous technical achievement. Since we had designed a standard console for the Typhon and Spade programs, we could quickly release drawings to the shop. We had the latitude given to a skunk works, so we could build to marked up drawings.

Although we were designing things for the first time our experience paid off. The designers were able to quickly resolve problems and release drawings to the model shop who fortunately for us were not fully loaded. None of our shortcuts affected the quality of our system. Everything passed inspection by both in-house and customer reps

and was delivered to the full-scale mock-up we were preparing for system test. The mock-up's floor plan replicated that of the former missile hangar on its host vessel, the USS Halibut, SSN-1. Tony Frezza's group had written the system software for the UNIVAC computer that we mounted in our computer control console. It was debugged in the mock-up as was the platform control console that we designed and built for our Sunnyvale division. When we finished our tests, John Gitt conducted customer sell-off. Years later, the customer was featured in the book "Blind Man's Bluff" and Wx was briefly mentioned. The book included a photo of Jim Bradley being decorated by the Secretary of the Navy. After retirement as captain of one of our nuclear submarines, Jim later became the Wx VP of marketing, Europe. After I started traveling, Jim accompanied me on most of my trips to NATO countries while he was based in London and Bonn. During all of the time we spent together, I never knew of his role in the DSSP area and he never mentioned mine. I never saw mission data on the displays. I wasn't read in to that need-to-know level of the program since I was not going to the field. Meanwhile, we had booked the contract for a second system and started releasing shop orders immediately.

Hochheiser:

Right.

Meren:

By now, plug-in integrated circuits were available in dual-in-line-packages, DIP's. We or other groups had evaluated each type as they became available. Bob Fowler asked me to replace the logic in both the display console and the scan converter and I agreed. Our factory had evaluated an automatic wiring machine which could accept a 300 position planar array and the vendor promised Bob a sample array of that size. That single array eliminated over 120 printed circuit cards. It only took me a couple of minutes to convince John Gitt, but it took two sessions with Dave B. They both trusted me and I knew how forgiving digital design was. The DSSP was one of my best ever assignments, mainly because of its legacy. We applied our double-ended scan converter knowledge and won our first FAA production contract, the RBDE-6. The 330 family of cards that we developed were used in the design of both the signal processor and display for the prototype AN/TPS-43 radar. After Dick Linder asked me to show him our 300 position planar array, he had Rene Rosenthal design a 100 position derivative of it which became the standard for nearly all digital design in most of the Baltimore divisions. A derivative of the film recorder was developed for NOAA. It recorded history's first color photograph of the Earth transmitted from a satellite in a synchronous orbit. That photograph was featured on the cover of Aviation Week. We also derived a film

recorder for the Japanese Weather Bureau. But another later derivative came about when Larry Nix and I were trying to squeeze more resolution out of a 16 inch CRT than it could provide. We made a chart of our previous displays and all were lacking except for the tube used in the film recorder's flying spot scanner. We asked our Elmira tube division to package that tube's electron gun in the neck of the 16 inch tube and met our needs. The tape recorders were eventually replaced with a magnetic disc recorder which our Research Labs developed as an offshoot of what we had done on the program. Beyond that, their work led to a TV slow-motion playback mode used in football broadcasts. The display consoles had applications on several other programs. The displays on that program marked the first time that side-looking sonar was meaningfully displayed in real time. Because of its low data rate it was usually recorded on paper. Bob Fowler designed what he called a rolling window display. The new data came in the top of the display and the old data rolled off the bottom, one line at a time. Each display pictured the previous five minutes of data. Two displays were provided.

Hochheiser:

Right. So you've got two side by side -

Meren:

Yes. One for each sonar, left looking and right looking. But you could also call-up other sensors. The platform contained a forward looking sonar. And the slow-scan TV could be selected. Early system requirements to display the mother ship's sensors were not implemented.

Hochheiser:

Right.

Meren:

It was a tremendous system. And it provided more than the significant legacy I described. From a business standpoint our controller told me that that program made our department's numbers for the year and for part of the following year.

Hochheiser:

Yes.

Meren:

In Jan ’66, a B-52 with four H-bombs aboard collided with a KC-135 Tanker over Palomares, Spain. Our customer turned us on for a quick react search system. One of my engineers, Ted Wright, quickly designed a real time low light level TV camera for the towed platform for that system. Jack Spangler led Ted and our display team for that effort, and we added more design expertise to our section. The 4th H-bomb was located by the Deep Submergence Vehicle, Alvin, operated by the Woods Hole Institute in their search sector off the coast of Palomares. In October of ’66 I was promoted to Supervisory Engineer.

Transmitter Programs

Hochheiser:

Where did you go after the Navy DSSP? Are you still working on CRTs?

Meren:

Yes. I still had the responsibility for all of the displays I just mentioned. Based on our prior work on the DSSP, I was asked to architect the display and control system for the Deep Submergence Rescue Vehicle. We had provided the display for the Deepstar to the Underseas Division and they wanted the Special Projects Office to add the DSRV to our support contract but the SPO awarded the DSRV to Lockheed and the Control Sphere to MIT’s Instrumentation Lab in Cambridge, Massachusetts. We proposed the displays to MIT. Underseas proposed the sonars. Earlier, Guy Bias asked me to transfer half of my people and their projects over to Frank Reynolds who was going to join our section. He had supervised the design of the UPA-48 that we had helped him with earlier. Then, in March of ’67, Guy asked me to manage the ALCOR Transmitter Program. It would become part of MIT Lincoln Labs Kwajalein radar. This C band radar tracks objects in space. The Power Generation Section recently taken over by Jack Geikler had won it. He requested help and I was loaned to him. Over the weekend I read the contract, went over costs to date and read the proposal. I realized what a novice I was when it came to the design of radar transmitters. My wife saw me moping around and I finally told her what I was worried about. She said does that mean you’re going to ask me to help you design something again? That cracked me up. But it reminded me that my job was to manage it, not to design it.

At my first Monday review I asked each engineer to describe what he was doing and where he stood. Hank Hiscox described the transmitter system. The final pulse amplifier

tube socket and some supporting circuitry were mounted in an 8x16 foot tank 6 feet high and was driven by cabinet mounted pre-driver and driver amplifiers. A high voltage power supply and a crowbar to protect the tube completed the design. One by one the design engineers described their parts and related it to Hank's proposed block diagram. The last block to be covered was the crowbar. Dimensioned sketches and schematics which augmented pictures of previously designed crowbars were shown. The designer in this case was a consulting engineer, at least three management levels above mine. We had never met. He described how interconnected high voltage vacuum switches through a resistor network established the discharge path and such. When he stated its shape and size as a cube whose minimum dimension was 14 feet I started asking questions related to its size. His answers about spacing and corona were clear. When he said why are you asking the same questions, I said I was just looking for an alternative. He said this is not a display we're designing here you know. I said okay, let's hear from our drafting supervisor and get a financial summary before we wrap this up, then we'll reconvene after lunch. To date, our drafting group had spent all of their funds on exploratory layouts, none of which were ever used. Also to date, 25% of the engineering allocation had been spent. I told our crowbar expert that I'd like to talk to him some more and we went up to his second-floor office. I closed the door and he said what don't you understand? I said I read in the proposal last night that the Army Corps of Engineers will build their standard 12 foot high radar building on Kwajalein and I don't understand how you're going to get a 14 foot anything in there. He said well that's not my problem and I said no, I'll take it now, it's mine. Incidentally, have you ever put a crowbar in oil? The breakdown voltage of the oil has to be high enough to insulate the tube socket and the crowbar's needs can't be any higher, right? Yes, but no one has ever done that before. I said we're going to end that streak. He asked where I had learned about insulating oil. I said I used to work for a power company and we stuck a lot of stuff in oil. After lunch I broke the hardware down into three assignments. Ed Piechowiak got the pre-driver and driver cabinets, Ray Lees got the HV power supply which was proposed as a subcontract and Bert Drummond, who had transferred out of my group a few months earlier, got the tank. I told Bert that his responsibility also included the crowbar since it was going in the tank. I asked for PERT schedules and estimates to complete engineering through in-house test. Guy had scheduled a meeting with Lincoln Labs for the following week for me to explain to them why we were going to overrun this CPFF contract. Such meetings are never pleasant and this was no exception. It was held in an auditorium about one quarter filled with more than the few people we expected. It included many engineers and managers, along with contracts and legal reps and the Deputy Director of the Lab who introduced me. My trip report included an almost verbatim quote of his very brief introduction. It ended with, I doubt whether we and Wx will ever get together on another contract. Fortunately, that wasn't the case. Several years later, after I presented an ARSR-3 paper at an IEEE conference, I sat in the

audience and listened to an ALCOR presentation by an RCA engineering manager. RCA had the system support contract on Kwajalein. Hughes had designed the antenna, we had designed the transmitter and MIT had designed the signal processing and the overall system. After the pitch I turned when I felt a tap on my shoulder. I heard, "Hi Lou. It sure sounded like RCA did the whole job by themselves, didn't it?" It was the Deputy Director of the Lab who had been sitting right behind me. I attributed our success on that program to the team of very competent system and design engineers who had already been working on the job when I came on to drive the bus.

A few days after we got back, Guy called me in his office and said that Jackson wanted me to take over the SPTF Transmitter Program. This was a High Power S-band Transmitter being designed for the Air Force's RADC Labs. The transmitter was going to be assembled inside an 8 foot shelter. The shelter would then be mounted on the back of the antenna on top of a 60 foot tower. Nearly all of the subassemblies were built and the model shop was getting ready to wire the shelter. This was a fixed price contract. When I got an overall cost report it had less than 100 dollars left before it hit our sell price. I stopped the job and had our controller set up a new task structure to accumulate costs in the pipeline and to provide budgets for remaining work. Then I had all of the hardware and the empty shelter moved into our antenna building for final assembly and test. We finished all assembly with one wireman and one technician then started test with Bruce Boyd, Al Morse, Fred Popodi and the assigned field engineer, all very competent engineers. That same week, our VP, Mr. Nick Petrou was on a plane with his counterpart Dr. W.E. Shoupp, VP of the Wx Research Labs in Pittsburgh who was chiding him about the already late delivery of his power supply. On the day he got back Guy told me that Jackson had given Jim Beggs my name when asked who the program manager was. He also handed me a copy of the distribution list to which I was to send a report covering the status of the program. The list included the five levels of management between me and Bob Kirby who was now heading the Wx Electronics Corp. The interworks requisition described a 250KV power supply mounted in a large pressurized cylinder filled with sulfur-hexafluoride, SF-6, gas, for HV insulation, and a control console. The system powered an underwater electron beam welder. Charlie Carter, a fellow engineer, was supported by Charlie Hooper, an advisory engineer and Ivan Rambo, a consultant engineer - again, all very competent engineers. I spent a half a day talking to them to get enough information for a program review with the customer and for the status report I was going to send to my very elite distribution list.

Hochheiser:

Did you have three groups under you, one on each program?

Meren:

Yes. Each group now had a schedule and spend plan, and we had weekly reviews every Monday. Everyone was also aware of all contract billing milestones. The first thing we shipped was our Hot Potato, the 250KV power supply. I included a one-level PERT chart in my first report which I updated in each weekly report thereafter. We bettered our projected delivery date by three weeks. In my final report I attributed our early finish to the fact that we did not experience any failures. At Mr. Petrou's suggestion we sent Charlie Carter to Pittsburgh to help set up the equipment. I got thank you notes from Messrs. Petrou and Beggs. I started spending my time on the other two programs as well as following some projects and proposals in the display group. About a year later I received a brochure from our Astronuclear Lab in Pittsburgh depicting their non-vacuum electron beam welder product line. The 250KV power supply that our engineers had designed was the heart of their system. They had done a great job. The system was soon transferred to a Wx manufacturing plant in Sykesville, Maryland where it became their cash cow.

Hochheiser:

So it fed into a completely separate division of Westinghouse?

Meren:

Yes. It was a commercial division and did not report to the Defense Center. In the meantime, design of the ALCOR and the assembly of the SPTF were moving forward. In the case of the SPTF I had traded time for money by limiting assembly labor to one wireman and one technician. I did that because I wanted the tech to help us test the hardware which he would then be very familiar with. The same was true about the field engineer except I couldn't have him assemble or wire anything because he was a non-union employee. Both transmitters used newly designed klystrons. Our radar expert, Dr. Peter Ravenhill, was closely following the final assembly and test of the tubes. Each program had two tubes on order. The tubes, each the first of their kind, cost over 115 thousand dollars each. Test of the SPTF hit a snag when a large assembly called the Pulse Leveler wasn't doing its job. Fred Popodi was testing from a position on the side of the shelter. I was there doing a report because it was 11pm and no one could work alone. My only duty was to turn the prime power circuit breaker off and on as Fred changed the location of his scope and high voltage meter probes. I had just turned it on and was walking back when a large oil-filled capacitor blew up and spewed most of itself out through the open door. It immediately reminded me of my first week at Wx. Fred, whose Austrian accent included rolling his R's said, "aha, therrre is the prrroblem." I

turned the breaker off, left a note for Bruce, had maintenance come in and clean up, then Fred and I went home. Soon the tube was plugged in and final tests began. Late one morning, our field engineer came into my cubicle and sat down. He was almost in tears when he told me that he had accidentally damaged the tube while changing it to test the spare tube. I asked him if the system was back on line with the spare running and he said yes. I said great. I called Pete Ravenhill and asked him to examine the tube, then contact the vendor and let me know what our options were. I told the FE to relax and come back after lunch. Pete called me back and told me that after seeing the damage that the vacuum seal had been broken, the tube had de-gassed and that the cathode was probably poisoned, but nothing that Varian couldn't repair. He had talked to Varian and told them that we were returning the tube. I started to breathe normally again. I already knew that Pete was an expert on both radar and tubes. When I wrote my progress report I downplayed the incident, and since the repair was covered under warranty, nobody got too excited. Our FE thanked me many times after that, mostly with his eyes.

We finished the test and got ready to ship the equipment. The tube was removed and packaged for shipment and the shelter was moving toward the loading dock with a flat-bed truck waiting alongside. Then the manager of the antenna building, Al Melvin, called me and said you better come out here. When I did, I saw that we had built a boat in the basement. During shelter mods, a waveguide flange had been welded to the back of the shelter making it too wide to go out the door. Al said what now? I said we'll have to remove the door to get to the frame which is bolted in and probably take out one column of blocks. He said we can't do that. I said call whoever you want who can, but that truck out there has to get this to RADC today or we'll miss a billing milestone. So we've got about two hours to get it lashed down. I had said the magic words. Within 20 minutes the removal started and I went back to my desk. An hour later the truck was on its way. I visited the site after it was installed. It was cold and raining. Bruce met me in the control room on the ground floor and told me to keep my raincoat on. We walked up through the inside of the tower, then through a hatch to an outside platform. There, an exposed ladder bolted to the outside of the tower was to take us up to the transmitter. The FE was there finishing up some tasks and soon the three of us went back down to the control room. When we got down I told Bruce that that was to be his last trip topside. During my Navy days I had scooted up and down ladders between decks hundreds of times. But my view of an over sixty-looks-like-seventy year old man shakily climbing up and down that ladder was not a pleasant one. Bruce had one more thrill for me. Part of our test plan included a test of the Crowbar housed in a large room next to the control room. It was part of the Special Purpose Test Facility from which our program got its name. Bruce had asked the customer to schedule the event and was waiting for the phone call to signal the okay. Bruce warned me that since this Crowbar

operated in air, there would be a loud bang. The phone call came, Bruce turned on alarms and pushed a button. The loud boom shook everything and minutes later when we went in to see the Crowbar dust was settling down over the components. The Crowbar hadn't been used for years allowing quite an accumulation of dust everywhere. My last task for the program was to ensure that the customer signed off our test so that we could take it into sales.

Most of my Christmas '67 vacation was spent in Rome, NY. Within the next six months the design of the ALCOR was completed and most of the hardware was ready for test. Again, the antenna building was the logical place to conduct our final tests. The tank had already been delivered to that area. Earlier, when our safety manager learned that we were going to have a large tank filled with oil he said that we would need a containment plan in case the tank ruptured. I hadn't been to the antenna building since I had them remove the door. When I went in, the first person I saw was Al Melvin. He said now what? I told him my plan as I was drawing a sketch. I sketched the tank at the opposite end of the building, drew a line around the tank and told him that represented a concrete block wall, two feet high. Then I sketched a holding tank and pump on a pad outside the building and pipes connecting the two tanks. My sketch and a charge number is all it took for him to have the work done. Assembly was completed and tests began in March. At one point Bert Drummond told me to stand close to the tank as he pushed a button. When I heard a click, he told me that he had just triggered the Crowbar. The Crowbar was later patented and lists Bert as the inventor. System tests were to continue for the next few months. We had started to prepare our transportation plan for review by the customer. It was to describe how we were going to disassemble the system for the flight to Kwajalein then reassemble and retest it prior to customer acceptance. The field engineer assigned to the program saved us a lot of effort. He suggested that each step in the disassembly process be photographed. Then he would reverse the sequence of photographs for reassembly on site. This very simple but elegant solution was accepted by the customer.

DSRV, Radar Contracts, FAA, 2402

In June, we were awarded the contract for the display and control system for the Deep Submergence Rescue Vehicle. Guy Bias said he wanted me back in the display section as Program Manager. We were awarded a CPFF contract to develop a TV display and a 10 inch round sector-scan sonar display then deliver 5 suites. Each DSRV required four TV's and three sonar displays, and with spares we delivered 45 total displays through MIT to the overall Submarine Prime, Lockheed. In early December I received a merit increase. It was followed by another one in early January. Two raises in less than a month. Both were signed by Guy Bias and H.L. Jackson and cited my assignments on the four

programs. The DSRV Program was the easiest of the four since I was back in familiar territory. The DSRV was the first of several programs we worked on, some for in-house programs and others which we bid and won directly from various agencies. During my loan, Al Surkovich kept my other projects going. We provided a scan converter and display for the Seek Skyhook radar. The radar was reapplied from an Air Arm radar code named Egyptian Goose and became the first tethered aerostat radar. It was soon followed by another system using a radar known as Pocket Veto. The aerostats were produced by T-com.

We then won an improvement program for the FAA's Radar Bright Display Equipment, RBDE-4. This was followed by a contract for a control rack assembly. This display digital processor assembly, used in an airport tower to control arrivals and departures, was housed in five cabinets. The display was furnished by the FAA. The design and manufacturing went smoothly and we moved the equipment into one of the radar labs for final test and sell-off. I was told that Mr. Petrou was going to drop in sometime during the test scheduled for the next morning. That night it rained and a few wet spots appeared in the ceiling tiles near the equipment. One of the shop touch-up people hung a large plastic sheet from the ceiling over the cabinets as a precautionary measure. The test started and I was off to the side with one of the FAA managers when Messrs. Petrou and Solomon came in. They both stuck out their hands and introduced themselves, first to the customer, then to me. After just a few minutes of small talk, the customer quality manager had a question for him and waved him over. Mr. Petrou said "Lou, what's that plastic hanging over the equipment for?" When I told him he glanced at H. Solomon who turned and walked out of the lab for a few minutes. The roof was moved up on the priority list and quickly repaired.

A few days after sell-off I was called to Jackson's office. It was 10am. He asked me to look into the status of the 2402 computer that Don Scott's section was developing for the Canadian Navy. He wanted my input and recommendations by 4pm. I was familiar with the program. I carpooled with Darryl Braman who I had borrowed on the DSSP and was now helping debug the first computer. Harvey Michalski and Sam Zimmerman were also hard at work on the job. Harvey later transferred to the East Building and was responsible for the design of the Wx millicomputer. When it was used on the harpoon missile I thought about how great it must be to work on an expendable product. I spent the next two hours talking to the shop. Then I talked to the engineers. I wrote three pages of notes and made a mimeograph copy for myself in time for the 4pm meeting. Don was managing all the technical activities and the overall program. My first recommendation was to add an experienced program manager to relieve Don of program duties so he could concentrate on the technical aspects. In addition to debugging the first unit a group of people were working on debugging the second

computer. The remaining computers were in various stages of completion. I recommended that they bring the first computer up to its final configuration then set up two overlapping test shifts. After the second item Jack said wait a minute and called his secretary in. He asked her to have Dick Broden come down. I finished reading the other items on my list as Dick arrived. Jack handed him his copy of my notes and after Dick read them he said any questions and Dick said nope. Jack told him that he would be the program manager starting tomorrow and that my notes were his preliminary program plan. We left just before Jack's next meeting at 4:30.

FAA Scan Converter Program

Hochheiser:

Okay, so you finished those programs, you're now a design supervisor and you're up to the FAA Scan Converter Program.

Meren:

Yes. The request for proposals was issued to supplement the equipment being used by the FAA for enroute air traffic control. The contractor for the replacement digital equipment was so late that the FAA had to buy over 130 more of the existing design. The same company, Raytheon, was supplying both systems and the FAA couldn't deal with the potential conflicts if they awarded a contract to a company because they were late on its replacement. Marketing learned that ITT and Bendix were going to bid. The equipment was not as complex as what we delivered to the Navy DSSP but the contract required development at a firm fixed price. I recommended that we no-bid. An FAA manager came to Wx and asked that we reconsider and I was asked to look at it again. Since the FAA had not responded to our requested change to a CPFF front end to the contract, I again recommended that we no-bid. The FAA then contacted Pittsburgh. As a result, Jackson said we want you to bid this job and we want you to win it. Our top management decided we were getting into the FAA business and this was going to be our entry. We won the job with the lowest bid, 0.1% below our nearest competitor, Bendix. We had a victory party and soon John White, who reported to Tom Porter, was named PM.

I could write a book about this program, but I'll give one example of how it changed our culture. We built a breadboard of the equipment then transferred as much hardware as we could to an advanced breadboard which would be our baseline. We also built a deliverable pre-production unit to prove our manufacturing drawings. Production release was dependent on successfully passing first piece inspection. For our military

programs, our quality department presented each first piece to resident customer reps AFPRO or NAVPRO. The FAA had their own rep, Ed M, in residence. I was asked to attend our first submittal which was a printed circuit card. The card, along with its manufacturing drawings and test data were laid out on the conference room table. All entries on the control tag were stamped. Ed looked over the documents, examined the card, and said this is by far the best first piece of hardware ever submitted to me. Then he asked John White where the purchased part drawings, the reliability data and a technical description of the card were. John said that will come later out of our parts, reliability and tech pubs departments. Before Ed looked at me I knew why I had been invited to the meeting. He said, where do they all get their inputs from? I said from design engineering. We use a PPD request which FAA has to approve for parts drawings. Our reliability and maintainability engineers use those parts lists to calculate MTBF's and MTTR's and suggested spares provisioning. Tech writers use that schematic to describe the card's function for the instruction book. All departments are included on revision notices when changes are made. He told John that all of that information had to be submitted with this and all future first piece hardware submittals and granted conditional acceptance of our first submittal. Most of these tasks were reviewed by engineering during the manufacturing cycle and represented an additional burden to us during design, but we complied. We uncovered some problems through the process so it turned out to be helpful. The best thing I can say about that program is that we survived it.

Soon after de-bugging our pre-production model, I received a call from our Manager of Security. He asked me to join him and a visitor in a secure conference room near the lobby of our central building. There I met a USAF Captain. Our security manager confirmed to him that I held a top secret clearance then left. Then I was read into a planned mission. He told me that I would be the only engineer cleared and that a contracts rep and one Wx executive would be read in. The Captain said that within the coming week we would receive a contract with a DX-A2 priority authorizing the release of our pre-prod equipment to the USAF for one month. He described the contract terms and conditions, how we would be funded, general instructions and the spec for packaging the equipment for overseas shipment. I asked if our support was needed and he said no - the team would modify and operate the equipment. What do I tell the customer's in-house reps? He said their management will tell them. He thanked me and left. I never saw him again. As I walked back to my cubicle I didn't even wonder if this Captain could pull this off because of what we had done on the DSSP which also had that priority. The next day I had my answer. A courier had delivered the contract to our security station. The customer rep told me that his manager told him that our pre-prod was not going to be available for a month. Whoever our executive manager was passed the word through our management chains to me and our program manager. We had

three days to package the equipment when the truck arrived for the short trip to their cargo plane waiting at the airport. Within a month they returned it. The customer thanked us and amply rewarded us. This helped minimize the overrun we were heading for. Years later I received a de-classified report that described the positive results that an agency had achieved with a system in Turkey used for monitoring some activity north of the country.

Meanwhile, the FAA program had attained high visibility status. Once a month the program manager had a face-to-face review with Mr. Petrou. At one point during his absence for a month I sat in for him. At the time most of the issues were smoothed out and our pre-prod had passed all environmental tests which permitted release of the first production lot. Just prior to that we won our second FAA production contract, this time for 200 22-inch diameter displays. I was program manager and Mr. Petrou was as interested in that program as he was in the scan converter program. So at two reviews we discussed both programs. Before we bid this job I visited the FAA's enroute Air Traffic Control Center at Leesburg, VA. The displays were provided by Raytheon and again they were not bidding. I sat at a display, watched controllers and talked to a few of them. I found out what they didn't like about the displays. First, they ran very hot. The input cooling air intake was in the rear and the hot air exhausted in the front right at the operator's shins. It was so hot that most operators used cardboard to deflect the hot air. This in turn caused overheating and many failures. Second, they ran very loudly and third, they were unreliable and failed frequently. The spec to which we bid addressed each of those issues. The display had to be tested to an MTBF of 2000 hours, exhaust through front vents was not permitted and a noise level limit of 95 dBa was imposed. Our engineers did great work on that display. The console was made from two aluminum castings, a base and a hinged top. The CRT and yoke were mounted inside the magnetic shield fortified to mount directly into the console. The video amplifier assembly was a small pc card which included the tube socket and mounted directly on the tube. All remaining circuitry, including power supply regulators, was mounted on two large plug-in PC cards, accessible from the top when opened. The cards were to be tested on a bed-of-nails automatic test set in our Air Arm Division. There was no fan in the unit. Everything went smoothly and our shop was quickly turning out the units.

Before we moved into our reliability demonstration phase I met with our manufacturing manager, Leo Chism. I told him that I would like to shorten the test time and asked him to loan us an area in the factory and provide 20 drop cords each equipped with a rheostat. The only stress test the spec called for was that due to line variations which we could simulate with the rheostats. We roped off the area and moved in 20 displays. Display stability was tested each hour by measuring any drift between a generated pattern and an overlay. The design was solid. We started the test on a Friday at 10am

and ran the test until Tuesday at 4. We turned off the displays and moved them to the shipping department. We passed the test in 100 hours. Our engineers had designed a great display. As a result, Ben Vester asked Tom Porter if he and I would brief some east building engineers. I would review how we cost reduced the design and Tom would quantify the resultant cost savings added to our division's bottom line. Tom asked which engineers and Ben said all of them. We covered them all in four sessions which included their supervisors and managers. We were politely received as expected. Later, Tom told Ben that his engineers were very interested when I described how I had de-composed the display requirements and how we had driven out a compliant design. But he felt that his part fell on deaf ears except for a few of the senior people at the meetings. On the way back I told Tom that many, if not most, of the design engineers I had come across didn't care a lot about spending other people's money. Occasionally over the next few years a few of the attendees told me that they remembered our visit. Many of the engineers in my group worked on the two FAA programs.

AN/UPA-62

In the meantime, our division had booked several TPS-43 radar contracts. Following the two prototypes, 17 were booked for the USAF and four for Israel. Each radar set included the PPI monitor we had designed for the prototype. These early radars were accompanied by shelters which included UPA-48 displays, the IFF interrogator, radios and phone communications needed to support manual tactical air defense. When we booked a three lot for Greece, Jackson peeled off profit dollars and asked us to develop a new general purpose PPI for the Greek program and future TADS. Its assigned nomenclature was AN/UPA-62. We assigned the project to Al Surkovich. He and his team designed a masterpiece. It was to become one of the finest pieces of equipment ever designed in the display section and most likely in our department. The display used the 16-inch high resolution CRT that Larry Nix and I brought on line, included a track ball, a digital target extractor and the capability to track 1000 targets. A far cry from our early displays at Parker Road. Al was personally involved from inception through production test. No detail escaped his attention. He set a new standard for engineering support to all departments. The display was used with all subsequent sales of the TPS-43 and for several other ground based and shipborne radars. A total of 950 were built, most at our facility in Puerto Rico where it became a cash cow. The tax policy covering that facility also improved the division's bottom line. Jackson wanted Al to demonstrate the display at the Paris Air Show as a reward for his remarkable effort. The UPA-62 was replaced by the AN/UYQ-27. It employed many more integrated circuits, we added an ASCII keyboard, an alphanumeric generator and a vector generator so that intercept problems could be solved on the display when the radar site was used as an air defense node.

ARSR-3 Radar, ADS-4, Proposal Work

During this time period our display section was combined with the Air Arm group responsible for airborne displays. The combined group was managed by Jeff Hamby. Our next task was the design of the AWACS ECCM display. We assigned Sal Cuomo as the project engineer. It was a derivative of the UPA-62. Al and Ted Wright architected the system and Ted designed most of the hardware. Soon after that we received the RFP for the FAA's ARSR-3 Radar. A CPFF contract for a prototype radar was issued, Dick Linder was the proposal manager, and I was picked as a member of the team along with Morris Tamres, Charlie Burns, Ed Piechowiak, Dick Schurmann, and Guntis Brunins. Each of us represented our functional areas. When I told Dick that the display requirements were very simple and Al Surkovich could address them with a stripped down version of the UPA-62 he said okay, but you are the only one on the team with any FAA experience so I want you and Guntis to break down the spec and hand down the requirements for the whole system. We knew this was a must win and we got all the support we needed. Guntis coordinated all of the systems engineering inputs, mainly from John Taylor and Coleman Miller, and I coordinated the design engineering through the people I just mentioned. I was assigned the technical volume and later Guntis, Al and I read and edited all of the remaining volumes. We won the contract in late '73. Dick Linder had taken over the equipment design engineering department, I was promoted to an A-level manager and assigned as engineering manager of the ARSR-3 radar reporting to him. I met with him nearly every day. I was a morning person so I'd often be at work at 7am, but my meetings with him would be between 5 and 7pm. Every day for most of three months I'd go over what we were doing that day on the radar and getting as much guidance as I needed. Additionally, he was teaching me a lot about radar.

Fortunately for me in early '74, I was a lot more independent because along with being the engineering manager of the ARSR-3, I was assigned as engineering manager of the ADS-4, the Iranian Air Defense System. That program, along with a lot of foresight from Linder and Jackson resulted in some first time developments for us. As we broke down the requirements, we planned to use the ARSR-3 prototype antenna and transmitter designs in the ADS-4 search radar. The solid-state modulator was applied to the nodding beam height finding radar. It would become the world's first HFR with a solid-state modulator. The UPA-62 displays were an integral part of the system. After we broke down the communications requirements we looked at telephone and radio needs for an operator in typical air traffic control and air defense scenarios. Each operator had a telephone and a radio control panel and headset. At that time that was the accepted communications method and we had applied it in our TADS shelters. But as the number of operators increases, so too does the number of cables and connectors. When I

showed the data to Dick he said we needed to simplify things. He had heard about time division multiplexing, TDM, and suggested that as an alternative. We had our communications and digital people from the section which Dick formerly managed put together an approach. Their analysis showed that the recurring cost of the replacement system was lower and the savings over eight systems covered the non-recurring costs. Dick set a meeting with Jackson, I briefed him and he said he liked the idea. He looked at me and said see if you can get the program manager to agree, and I did. It became the world's first TDM system which combined all telephone and radio activities throughout the system through a single headset. And when we did that we got rid of a lot of wires and cables.

These two programs were really the pre-cursor to the ARSR-3 production program. The FAA released the RFP and it covered what we expected. It covered 22 fixed station dual-channel and three mobile single-channel systems. The contract would be firm fixed price and compliant with all of the specifications we met on our scan converter and display programs. I managed the proposal which required seven volumes cross-referenced to the specs. But the most important part of the bid was our cost proposal which Dick Linder managed. He isolated Dick Schurmann and had him create a straw man cost for the competitor he picked to beat, Texas Instruments. We were happy to win and beat GE, Raytheon, Hughes, Bendix and T.I., the next closest bidder by a very narrow margin. Our first task after winning the contract was to reconfigure the system using the value engineering change proposal process. At Dick's request, we had prepared a list of potential changes during the proposal phase. The first proposal changed the specified packaging of the radar from five 12x40 foot mobile trailers to a single building. A second proposal described the implementation of all digital design with our standard planar array rather than with the small size printed boards specified. In all we submitted seven VECPs. I briefed six of them and Rene Rosenthal briefed the digital planar array proposal. All were accepted and savings were considered profit. Guntis Brunins rewrote the spec encompassing all of the changes and gained customer approval.

I continued my assignment as engineering manager by issuing a directive which encompassed what we learned on our previous FAA contracts. The directive defined all of the items that each design engineer needed to include in his design specification. It went beyond the items in the engineering manual and included all data that other departments would need to meet their requirements. The major difference was that I requested it up front while the design was still fresh in the designer's mind. Dick wanted a design-to-cost approach and had me develop cost targets. Therefore each D-spec included the projected production cost of the design. Dick arranged for a buyer, a manufacturing estimator and a cost accountant to share a cubicle in our program area. We prepared a detailed schedule for the radar, top-down to the lowest replaceable unit.

Progress was color coded. I arranged for Fred Popodi to review all analog designs and Sam Zimmerman to review all digital designs prior to my sign-off and submittal to drafting. During a cost review of the signal processor, the top cost driver was found to be the wired drawer assembly. This was due to all of the wiring to and from all of the front panel switches specified. I pointed this out to the design group for at least three weeks in a row. Then it moved far down the list and I found out that the design engineer had replaced all of the mechanical switches with light activated digital switches. The switches were activated by an infrared light wand through a filter making it impervious to ambient light. Each switch had an address in the TDM Loop which tied everything together. I thought it was a very innovative approach and asked what motivated him to come up with such a classy solution. He said they got tired of me bringing it up every week. The design moved smoothly. Dick really fortified what I had learned from Dave Balthis about paying attention to details. He would often say there's no substitute for visibility. Because of the visibility I was getting in response to my design directive, I told Dick that I wasn't concerned about passing either our environmental or reliability tests. That statement came back to haunt us when the radar was tested to an MTBF of many more than the required 1500 hours and we weren't going to share in the future savings.

Hochheiser:

Did you travel to Iran as part of this?

Meren:

No, I've never been to Iran. I didn't start international[ly] traveling for the company until about 1980. But the ADS-4 opened the door for us. Many Iranians visited and were trained while we were designing their air defense system. Later, in addition to our support team, many Westinghouse people were helping put Iran into a lot of businesses. Just before things crumbled, Dick asked me to put together a proposal aimed at putting them in the radar business. Gary Evans drew our concept for a cylindrical array air traffic control radar. Dick delivered the proposal and pitched it to the customer, Admiral Aboul Ardalon. When Dick got back he was optimistic. Then the Iran we knew disappeared and Harry Smith sent a plane to Iran for our people and their families.

Hochheiser:

Right, I've heard that story.

Meren:

A lot of Iranians managed to escape with their families. Admiral Ardalon was one who did and came to work in our Air Defense Systems Programs Department. He also, as Dr. Ardalon, taught at the University of Maryland.

Power Generation Section, Laser Pulsar, FAA and Lincoln Labs

Hochheiser:

Now it's early '74 and you're engineering manager of these two programs.

Meren:

Yes, until November 1st when I was promoted to a B-level manager and took over the Power Generation Section which I had been loaned to seven years earlier.

Hochheiser:

So about how big an operation was this? How many people?

Meren:

About 75 design engineers in five groups. The section was responsible for the design of radar and communications transmitters, radio frequency generators, laser pulsars, inductive components, power supplies, filters and microwave integrated circuits, MICs. These were manufactured in the MIC Lab which I also managed along with its 15 people. Most of the section was heavily involved in the design or follow of these elements for the ARSR-3 and ADS-4, but the first program I had to address was an NRL contract for the delivery of L-band power modules. This program had been booked through Dr. Paul Pan who also managed IR&D funds for the center. The supervisor who booked the job was one of the best at winning development programs that I ever managed - the world's first solid-state L-band power amplifier was won by Bob Gardenghi. When I reviewed the program I could see it was heading for an overrun. Our only hope of avoiding it was to book an order for spares before we closed down the line. The next day I went to Bob's program review with Dr. Pan. It was a short meeting but I knew before it ended that Bob had just about broken his pick. I was asked to stay and listened while Dr. Pan vented his spleen. Then I told him that I thought we had a recovery plan if he would allow us to combine the spares order with the basic contract. He quickly agreed and said he was glad I was taking over the section. When I got back I told Bob that I would be his interface with Dr.Pan. I told the design engineer Ken Lee that he was

now going to be the project engineer. In short, the project became a technical and financial success. Ken Lee did a great job finishing this job during which he had to help solve device problems the vendor was having.

Solving vendor problems got to be a habit in our early days but Ken and Al Morse and Ted Foster, whose group designed our RF modules, never let them slow us down. Ted was also one of the most intelligent engineers I ever managed. On top of that he was a hands-on PHD. In addition to the early work I just described, Bob was responsible for selling the first solid-state modulator which used a gated silicon controlled rectifier invented by our Youngwood Division. He later led the proposal and won a contract from the Air Force Weapons Lab for a high power laser pulsar. The CPFF contract included funds for Youngwood to increase the device to the size of a hockey puck for a higher power output. Simultaneously, the AFWL had awarded a contract to RCA which applied silicon controlled rectifiers which they designed and manufactured. Soon after I took over the section, Ed Hooper, who was the project engineer, was ready to demonstrate the unit. It passed its tests and was packed and shipped. The pulsar was delivered early and a lot of money was left unspent. This was practically unheard of but the customer was happy. We were already sure that we were going to blow RCA away and win the next phase and having a happy customer wasn't bad. Two weeks later the customer called and asked me to visit the labs. When I asked if he wanted me to bring anyone he said no, he just wanted to discuss the next phase with me. So I flew to Albuquerque on a Thursday. The next morning I met the Colonel whose section managed the program. He told me that his orders were to transfer our remaining funds to RCA who had submitted a request for funds to cover an overrun. He told me that the RCA request was just one of a number of requests from other contractors and the command had to make some moves they didn't like. When I asked why they just didn't cancel the RCA contract and let us start phase two, he said they did cancel other contracts but we gave them some breathing room and that some of their programs, including our hoped for phase two, might not happen. He told me that everyone who saw the equipment was very complimentary then told me how sorry he was. When he asked for my comments, I said Colonel, we just made a full fee on a program that we under-ran, delivered early and we met your every contract requirement. Those words usually describe a winner. I usually write a closing report on jobs that I complete. I'm going to give this one a subtitle and call it A New Way to Lose. I had some time before my flight back so he took me on a short tour of the lab. During lunch at the Officer's Club I told him I had thought of another potential title, My AWFL Experience. When I got back I told Dick Linder to forget about phase two as an objective for 1975. Dick was a strong believer in Management by Objectives. That was his style when he managed the Receiver/Signal Processor Section and when he took over the department he brought it with him. Each section manager's list of objectives included those obvious to the support of in-house programs. An

additional objective stated the total value of hardware development and study contracts we were expected to book. A final category covered professional objectives such as patent disclosures and papers published. Obviously Dick tied performance against objectives to his management merit plan. There never was a phase two laser pulsar but the ARSR-3 transmitter modulator became the first of many opportunities to apply the device and we capitalized on every one of them.

By June of 1974 the ARSR-3 had been tested to an MTBF of 1500 hours which was unheard of at that time. But when 1500 hours was reached, Jackson wanted to let the test continue, and so it did. During the added time, many visitors came to see the system. When Mr. Petrou was scheduled to visit, Jackson called me and asked me to be there. The test was being conducted at our antenna range. When Mr. Petrou arrived I was standing to one side and he nodded to me. The program manager briefed him and he congratulated everyone. Before he left he walked over to me and we shook hands. He said, "good job Lou. How much did all of this extra reliability cost you in engineering?" Before I answered him I paused. I remembered reading that someone answered a similar question by saying that improved reliability was a natural fallout of the design process and therefore free. I told him that I haven't figured it out yet and that Dick and I were still trying to figure out how to get a part of the tremendous savings the FAA was going to achieve because of this higher reliability. Then he smiled and said, "keep working on it. I just read where some idiot said it came for nothing." That was the last time I ever talked to him. The ARSR-3 led the FAA to specifying unattended radars in future contracts.

Meanwhile the NRL module became part of their unattended satellite communication system, White Cloud, and the first operational application of our solid-state microwave technology. When Dick and I showed the module to Jackson he was very interested. The module power of around 110 watts was too little. We soon decided to develop a 500 watt module as a basic building block. We tailored the design to the thick film capabilities of the MIC lab. Our objective was to combine ten modules into a chassis which included an inverter power supply. We soon won an RADC contract to develop a ten KW UHF amplifier which we achieved by combining ten 1KW modules. This contract proved that our fundamental design concepts were sound. We developed a T/R module, also at UHF for NADC. Then MIT Lincoln Labs released an RFP for a 5KW L-band power module. It was to be part of the radar they were designing for a remotely piloted vehicle, RPV, that had been funded by a government agency. The system required a much longer pulse than we had been working with so there was not much we could carry forward. MIT told us that we turned in an excellent proposal but our costs were higher than the other bidder, GE. That was a tough loss. And losing to GE made it a lot tougher. But about 8 months later, I got a call from Lincoln's program manager. He said

"Lou, will you guys still do the job for us at the price you quoted?" I said yes. Because of the classification of the program we could never get any information about the status of the program after we lost it. But GE defaulted. Lincoln gave us the rest of the money and GE had to put up the difference. I hoped that would never happen to me, and it never did. We designed a great unit. We satisfied Lincoln Labs and they thanked us. That program put us out front for some time.

Long Range Radar and Iran, Proposal Writing

In '75, Jack Tymann was managing much of our business in Iran. He met with Dick and I and laid out the strategy for an RFP that was soon to be issued by the USAF for a long range radar. Iran was targeted as the first application for this radar because they were going to fund the program even though our ADS-4 radars would cover their needs. Every radar competitor we had saw this as an opportunity to penetrate the very strong position we were in which had all started with Jackson booking the ADS-4. We had to win this job to kill the competition. Jack added we would lose confidence with the customer as well as a lot of additional business we were pursuing if we didn't. If it came to that, Jack would have to convince the customer to kill the requirement, but only if it did not damage our relationship with the USAF. I was assigned to manage the proposal. We decided that it would be our first modular proposal. The ADS-4 radar site was at the top of Karadj Mountain and some early tests in conjunction with one of our TPS-43s at a much lower elevation permitted us to demonstrate the performance of the radars due to anomalous propagation or ducting. Our system engineers had sent us display photos which showed how well our processors handled second time around echoes and more. They once identified fourth time around echoes as those from the Spanish Alps. We made that an element of our win strategy. As it turned out, one of the USAF organizations we shared that information with was issuing the RFP for this radar. I borrowed Guntis Brunins again and we set up the outline. All proposal inputs came from the supervisors in each section. Our systems engineering consultant, John Taylor, wrote the modules covering weather performance and performance in ducting. Guntis and I had very little trouble fitting the write-ups into the 100 page limited proposal specified in the RFP. We met our objectives. We soon received the RFP for the AN/TPS-63 and its dual version, the AN-TPS-65. This L-band system would become the 2D tactical radar for the U.S. Marines.

The transmitter we proposed used a 5 KW Traveling Wave Tube, TWT, to drive a 60 KW cross-field amplifier, CFA. Additionally we proposed the frequency generator and the power supplies. Dick was managing the proposal. I had read and edited all of our inputs and after I turned them in he said he would like me to help him edit the rest of the technical volume. He also asked me to borrow Guntis to review all of the trade studies

specified in the RFP. Earlier, Dick introduced me to Peter Swerling who he had brought on the proposal team to provide the trade study dealing with target radar cross-section. John Taylor wrote the weather trade study. I told Guntis that his career had risen to new heights since he was going to review the work of the person who introduced the models, named after himself, that he would be analyzing. We finished on a Friday but before I left Dick handed me a stack of draft appendices. These were mandatory plans covering reliability, maintainability, manufacturability and quality. When I asked when he needed them he said Monday. I spent most of my weekend on that task. By noon Monday he had the new draft copies. He called me and said that he wanted them reviewed by the managers whose people submitted the original plans and then resubmit. Two of them quickly agreed. The third told me to give it back to the person who wrote it. I said no, you read both versions then decide which one to turn in. If you stick with your original cut and paste version, make sure you delete those references to how great a job your department is going to do for the Air Force and tailor this plan to the U.S. Marines. We won the program and Jackson almost immediately targeted the TWT driver for replacement.

Point Defense Radar, Power Supplies

The combination of Jackson and Linder started driving us into the solid-state RF power business and we booked some great development programs before we replaced the TWT. Most notably, we designed and built the transmitter modules for the SeaSat program which our Space Division was doing for JPL. A few minor component changes were all it took to space qualify the hardware. The modules were later used in the space shuttle's LandSat radar. We also developed our part of the AN-SPS-58 as the U.S. Navy's Point Defense Radar. While our program group was testing the radar, whose range was twenty miles, Jackson called and asked if I could play that radar through one of our FAA Scan Converters onto a 22-inch horizontal display. I asked my former group to modify their breadboard and move it [to] a display down the hall to the radar lab. As usual, we had to blank radiation sectors which would cause interference with the radars at the airport and with other nearby agencies. So when they set up the equipment I told them to offset the display so the blanked portion was off the screen. When Jackson saw the demo he smiled, said thanks and left. He could look out the window and see a plane landing then look at the display and see its raw radar return. It was the size of a golf ball. He had been thinking about applications of the scan converters, but that one didn't pan out.

Meanwhile, Ray Smith's power supply group was designing the power supplies for the 616A Survivable Communications System. This program was in Art Monheit's department along with the Navy programs that were transferred to him by our new GM,

Maurice Ani. One day, Dick said Jackson wanted to see us. He said he was tired hearing about all of the power supply problems we were having across the board. At the time we were buying most power supplies outside. We often helped solve vendor problems. Then he said there's a place down on Howard Street in Baltimore that we're trying to set up. I want you to put them in the power supply business. And I said okay. Two things I had learned about Jackson, he never wasted money and never wasted words. We had designed a conventional 616A power supply to deliver raw DC to the inverter supplies which were to be mounted in the receiver chassis. We were still waiting for the final requirements for the receiver power supply. Over 350 were needed. On my first visit to Howard Street I met Pete Bishop, an East Building Manufacturing Manager. He had been advising the facility manager, Irv Thompson. After a quick tour I was asked what I thought. I said I thought they released the wrong product to them. They did a great job on the printed card assembly but they haven't been sufficiently trained in wiring and cabling. They need some help with their test station. This is an Air Force Program and AFPRO will never sign off on this. Also, I don't think they can find a lot of stuff in their disorganized storeroom. I was getting ready to leave and talked to Pete privately. I asked him what the story was. I didn't have to tell him anything about manufacturing. He told me that he couldn't find too many people interested in getting them up and running. I said well, I've got a different set of marching orders. I'll have an engineer help it through test. Ray had assigned the receiver power supply to Howard Ginsburg and I met with them both that afternoon. I told them that we needed to design a power supply that would match the capabilities of the people who were going to be building it. They are very good at assembling printed circuit cards and not so good with wiring and cables. So see if you can design it on PC cards with no wires. Then I asked Ray to assign someone to design a test set to test the power supply. The next time I saw Howard he showed me a four inch square, one inch thick sandwich sized assembly of two PC cards facing each other. The cards were interconnected with a flexible printed cable. The assembly was designed to plug into the receiver drawer. And when I finally saw the test set, a tester at Howard Street was demonstrating it to our manufacturing and test managers, Jackson, and myself. Our design engineer had it built at Howard Street. It had more bells and whistles than I thought it would, but he later told me he thought it would be better for the users. It was better than anything in our test department. When Jackson saw it he was impressed. He said to Leo Chism, "you did a good job on this and you should have one in our factory that can test RF Modules. We're going to need plenty of them in the future." After the meeting Leo asked me to bring his test manager up to speed.

Hawk Digital Processor, NASA

Soon after that, our processor group won the production contract for the Hawk Digital Processor.

Hochheiser:

The Hawk Missile?

Meren:

No. The processor was for the Precision Approach Radar which was part of the Hawk System. It was basically a digital MTI processor with I and Q four pulse cancellers. We applied this approach to the Iranian Search Radar that I talked about earlier. This job was a thorn in Raytheon's side because Dick had sold this program directly to the Army. Dick told me that it had taken over seven years to get this production contract. We were going to design the multilevel power supply for the processor. Before we started, Dick was walking past my office one afternoon and stopped in for less than a minute. He said Lou, I'd like you to put something proprietary in the power supply you're doing for the Hawk. I said Dick, It's a power supply. He said yeah I know, but figure something out. On my way home I thought about the last power supply design I had reviewed and signed-off. At the time, we were using microcircuit regulators in TO-5 packages. All of the components including power output transistors and their heat sinks were mounted on plug-in PC cards. Inductive components were chassis mounted. I couldn't think about anything I reviewed that could be made proprietary. Then I started thinking about the last proprietary drawing I had signed and I knew immediately what to do. Part of my responsibility included management of Mike Kline's Microwave Integrated Circuits Lab. Our RF power modules were mounted on thick film substrates which formed the basis of our hybrid circuits designs. This lab was supervised by Ted Foster who was also responsible for the design of all of our RF power modules and all of our processes were proprietary.

The next day I met with Ray Smith and Ted and drew a sketch of what I had thought about and they took it from there. As a result, our Hawk regulators were mounted on a two inch square thick film substrate which was assembled inside an aluminum housing, one-quarter inch high. The regulators were mounted upside down on the substrate, a few chip and discrete components were used then all interconnects and remaining components were printed. It was a great package. Later, Jackson asked me to put together a priced list of equipment that we used to manufacture the regulators. He told me that a Dutch company wanted to co-produce the Hawk DSP for some of our NATO orders. The equipment cost 15 thousand dollars. When he asked what I thought was a fair price for the data rights I told him I hadn't the slightest idea but if it were an RF

module, I would start at ten million. So the power supply regulators should start at around 50K. I don't know the price he settled for and never asked. But about eight months later the Dutch company placed an order for over 200 regulators. They decided to quit trying to co-produce them in Holland. During that period, we won the contract to provide 8 L-band ATC radars for Canada. Although these were short range ASR's for use at airports, the Canadians did not follow the US FAA's history of using S-band at terminals. If they had, we probably would not have bid against the US incumbent, T.I. But we considered L-band our radar frequency domain and didn't want the ARSR-3 losers back in the game. We designed the transmitter frequency generator and all of the power supplies for the radar system. Earlier, we were awarded the production contract for 57 TPS-43E radars but this version did not require many changes to our parts of the system and supported just a few engineers since the major change was in modernizing the signal processor.

Our programs group booked a classified program known simply as RFN, Radar for Navy. It was managed by Dick Fowlie and we did the transmitter and our other usual subsystems. I first met Dick after Guy Bias asked me to look into the status of equipment we had developed for NASA's tracking radar at Wallop's Island. That was when I first met Guntis Brunins who was debugging the receiver and Tony Krauth who was debugging the signal processor. They were also trying to write the acceptance test spec in their spare time and deal with customer concerns which were forcing them to re-work some areas. I told the engineers to focus on the hardware and worked with the customer to sort out some interface issues. Some of the open items were NASA's responsibility and some belonged to the original equipment manufacturer, RCA. When I got back I told Guy that the engineers didn't need any help but the program needed a leader who could finish the acceptance spec, deal with the customer and sell it off. That leader became Dick Fowlie. We also designed a family of transmitters which shared as much circuitry, power supplies and control functions as practical. This hardware was developed for our Product Quality Lab and used to evaluate the ECM pods being designed in the East Building. The AWACS was experiencing high voltage transmitter problems and we built a corona test set at Johnnie Pearson's request. We serviced another walk-in request, this time from Ben Vester, to test a system suffering from environmental problems. It was delivered to our lab. I assigned Roy Anderson to evaluate this system which was packaged in several chassis and cabinets. During that week he tested the equipment, designed and added the required modifications. Then the equipment was gone. Roy and I did not need to know what or who the system was for.

Hochheiser:

Yes.

Promotions

Meren:

In the middle of 1978. Dick Linder moved to the East Building where he took over the Electronic Warfare Department. In September, I was promoted to a C-level manager and named Manager of the Equipment Design Engineering Department. Cal Jones managed the Antenna, Microwave and Facilities Section, Wally Hoff managed the Receiver and Signal Processing Section, Ted Foster managed the Power Generation Section and Fred Timmel managed the Display Section. The position included management of drafting, the engineering vault, technicians, seven labs, the Hybrid Circuits or Thick Film Lab, and clerical personnel. And in November I was promoted to the D-level Corporate Grade Position. This was a great position. Dick had it running like a well-oiled machine and I also had inherited his deputy, Tom Tomlinson, to help me through what became a seamless transition. Dave Balthis was working with Tom and replaced him when he moved to the East Building with Ray Robely. Tom was one of the principal unsung heroes who guided my career. In my new role, I could focus on managing the design engineering function while he took care of everything else. On the day I took over the job, my first visitor was Cal Jones, manager of our antenna and microwave section. Cal's section had scored one of our greatest wins, the Ultra Low Side-lobe Antenna, ULSA, for the TPS-43. During a review of antenna patterns, someone in the customer community had convinced their top management that the antenna design was flawed due to the presence of an anomalous lobe. The customer wanted Cal's manager, now me, to meet with the top management at RADC and answer the show cause letter we had received and convince them not to cancel the contract. Cal told me that he and Gary Evans had already started Coleman Miller working [on] the problem and a briefing was underway. Cal arranged for Gary and I to attend the meeting. Gary would give the pitch. I had worked at Wx for over 20 years and never saw a threesome like them. Gary was a hands-on PhD genius who greatly respected Coleman Miller's inputs. I felt that Coleman was a genius as well. Cal was very fortunate to have their support until he retired. Gary gave a masterful briefing as usual. The customer understood our reply and withdrew his letter. The program continued and became one of our greatest successes.

Hochheiser:

Right

Moroccan Air Defense Program, Section Workloads in 1979

Meren:

Then, Jackson's department booked the Moroccan Air Defense Program.

Hochheiser:

Moroccan program?

Meren:

Yes, Jackson's advanced program manager, Joe Mitchell, had pursued this program for a long time and he finally brought it home. I said 'he' because I don't know anyone who helped him. He was gone for long periods of time and I rarely saw him but he really worked hard to bring it in.

Hochheiser:

Okay. And that's about when?

Meren:

Around '79. That program gave us the opportunity to make improvements to our baseline products that would have taken us years to implement. Most of the improvements were made in the power generation section which I had just left. They designed a solid-state modulator for the eight TPS-43M radar's transmitters. They also designed the 5KW replacement for the four TPS-63 radar's TWT driver, most of the power supplies used on the program and the RF power modules for the world's first solid-state IFF interrogator. Dick Schurmann supervised the design of this unit and his group designed the digital hardware for it. The IFF systems were used with both radars and fit into a drawer in the TADS shelter, replacing the old cabinet version which was always either bought outside or furnished by the customer. Dave had been managing cost and schedule visibility reviews and I fit them into my schedule. At some time prior to this assignment I had worked with every supervisor in the department. In addition to the section manager, reviews included those supervisors.

Everybody in the department was very busy that year. A snapshot of our activity in February of '79 would show that Ted Foster's power generation section was designing power supplies for the ARSR-3, the Moroccan ADS and the Hawk DSP, a total of 17 different designs. The section was also designing the family of transmitters for PQL, an automatic test set for the ARSR-3 transmitter modules, mod kits for the Navy SPS-37,

the TPS-43 solid-state modulator, TPS-63 solid-state driver and frequency generator for the Moroccan radars, the TRACS transmitter for the Canadian radar, the MIT L-band transmitter, and designing and manufacturing the RF modules for the JPL/Space Shuttle Radar, the solid-state driver for our SPS-65 and the 120 watt driver for the ARSR-3. Fred Timmel's display section was designing the display and scan converter for the EAR, a display for the HELRATS, a digital video mapper and design modifications to the UPA-62 display which converted it to a programmable display with the new US military nomenclature, the AN/UYQ-27 and a display for the Marine Air Tactical Control and Landing System, MATCALS, which was a companion to our Marine Corps AN/TPS-63. Wally Hoff's section was designing the Spalding signal processor for a nearby agency, signal processors for the ARSR-3 and TPS-63 for Morocco, Digital Target Extractors for the ARSR-3. TPS-43 and TPS-63 Morocco radars and the solid-state IFF's for the -43's and -63's for Morocco. Cal Jones's section was designing the TPS-43 ULSA, and an L-band ULSA for the Hawk, a waveguide glide slope antenna, the TRACS antenna and the rotary joint for the SPS-10/65. Cal's facilities groups were designing an operations shelter for Korea and a similar shelter for Argentina as add-ons to our recent sales of TPS-43's to those countries. These shelters contained what was required to convert a radar site into a tactical air defense site or, as in Morocco, it served as a node in a country wide air defense system. They were also designing the communications, operations and maintenance shelters, and modifying the TPS-43 and TPS-63 radar shelters for the Moroccan system. The communications shelter included the VOCOM system we developed for Iran. The group was also designing mods to our TPS-61 shelter. Cal's group was responsible for the assembly of all of the equipment inside the customer's facility in Morocco.

When I met with Jackson and talked about what we were planning to do for the Moroccan program, I told him I thought we could do it because everything we were going to do with the exception of the solid-state IFF was being launched from a solid foundation. He knew all about our foundation because he had funded a lot of it. When he asked what my disaster plan was for the IFF I told him that we would fall back to the off-the shelf systems we used in all of our other shelters. We always had them available. Then he asked me what I thought would be the toughest job. I said the solid-state modulator for the -43. You've already done it for the ARSR-3 and the ADS-4. Do you want to take it off the list? I said no, because I don't know when we'll get another chance. When I talked to Dick, he asked me if I thought I was biting off too big a chunk. I said I wouldn't do it without the people I have. And so we did it all. We also installed our first TPS-63 radar on a tethered aerostat. We needed a new lightweight antenna and Morris Tamres found one made of aluminum coated plastic which worked very well. When Jackson was invited to see the system he asked me to go along. He was impressed as we all were but he told me that he didn't like his radar sharing space on

the balloon with a gasoline powered engine generator and its fuel tank. He said we should be feeding power up the cable. Radar data was passed down the tether cable and soon after I passed his comments to T-com, which we then owned, power was generated on the ground and fed up the tether. This Lighter than Air Surveillance System became known as the LASS.

Tactical Radars, TAFLIR

Hochheiser:

So you were in that position for about a year and then you became Engineering Manager for Tactical Radars.

Meren:

Right. In a reorganization, Pearson was named GM of Matrix Engineering and Wayne Fegely and Hank Airth were promoted to general managers. Hank was now the manager of engineering for Maurice Ani's Command and Control Divisions. Both George Martin, who managed system's engineering, and I reported to him. After a couple of months Hank asked me to set up an engineering organization for the tactical radar department managed by Jack Tymann.

Hochheiser:

Okay.

Meren:

During the first month of my new assignment we won a contract for 13 TPS-43 radars for Saudi Arabia. These would be used by the Saudi ground forces as defense acquisition radars for the Hawk missile. We had bid the program to Litton Data Systems who had the prime contract with Saudi [Arabia]. My role in this win was minimal. I read and approved the specification for the radar before we signed the contract. It had been prepared by George Bone and required only minor changes and I confirmed that those changes requested by the customer were covered in our cost proposal. I rarely participated in contract negotiations and whenever an engineer in my organization attended I would make sure that he understood that our contracts rep was in charge and he would ask for any information he needed from the rest of the team. When we returned from Litton/California, I assigned Frank Hodges as engineering manager.

Although he was considered an expert in the design of low noise torpedoes, he quickly became self-sufficient and helped drive the radars through the shop to delivery.

Earlier, the programs department had been paid to participate in a fly-off against Hughes in Switzerland and George Bone had managed our team. Our candidate was the multiple beam TPS-43 with a range of over 200 miles and theirs was a pencil beam mortar locating radar with a range of 20 miles. The Swiss scheduled a visit to debrief us and to give us the opportunity to tell them what we would do to meet their requirements for a 60 mile 3D tactical radar. The Swiss acronym for such a radar is TAFLIR. We knew that Hughes would have a hard time converting their entry into a 60 mile radar. So it came down to the difference in radar architectures. It would be the first time we had to compete against it and we didn't want to see Hughes in our sandbox. Before the Swiss visited us, I met with Coleman Miller and asked him if he thought a version of the ULSA would be beneficial to the TAFLIR. He said yes. I didn't have to ask him my next question. He said now that we have a set of antenna patterns, we have proven our computer program and all of our tapes for machining the slots. From now on, if we are given a limit, we'll start from that number to work the problem in reverse to get our tapes. I told him that so far our export experts haven't found anything I can use as a guide if we have to modify our export license. Then I started to prepare my briefing for the Swiss visit. By that time, we had developed a tremendous array of subsystems for the radars we produced which I already discussed. Nearly all of our designs were modular - we could apply them to meet the requirements of emerging systems. That was the approach I took in preparing my briefing. Our meeting with the Swiss, which I asked Coleman Miller and John Taylor to attend, began with a review of the data gathered during the in-country tests. Then they asked what we would do to improve performance before they issued their RFP for a small production lot.

In my briefing I began with a chart summarizing the performance of each subsystem of the radar that we had tested in Switzerland. I then walked them through the design of the system we were planning to propose, starting with the antenna. We would use a version of our ULSA antenna for side-lobe levels equal to or lower than the 23dB theoretical limit of reflector antennas such as our TPS-43. Next, we would use a solid-state modulator in the transmitter for improved stability. I told them that the modulator had been designed for the TPS-43M for Morocco and was also a close cousin of the Swiss ARSR-3 radars now operational in Switzerland. Gerry Steele had done a great job managing that program for Wx and we were always proud to refer to it. I then said that we would use four-pulse I and Q MTI cancellers to replace the three-pulse cancellers of the test system. Finally, I described our array signal processor, ASP, as the post-processor we would use for digital target extraction and capable of tracking a thousand targets. My pitch included performance charts and photographs of all the hardware I

talked about and we arranged demonstrations of everything I discussed. After a brief caucus their leader, Bruno C., said they didn't have any questions. He said they were shocked and pleasantly surprised at how far we had come in improving the TPS-43 beyond the version tested for them. Then they left to visit Hughes for the same type [of] meeting. When the RFP came out, Jack Tymann held a meeting to make proposal assignments and lay out our strategy. The usual assignments were made, then we talked about our win strategy. My input covered existing designs, low risk, proven performance in mountainous terrain, and modern hardware. A couple of days later, Jack introduced me to Dr. Nick Begovich, an engineering consultant he had retained to help me with the technical proposal. I learned later that he had once been a Hughes VP, then later a Litton Data Systems VP and most recently a consultant with APL. But first I learned that he was one of the finest people I had ever met.

We quickly got to work. I gave him the briefing I had given the Swiss and then we reviewed our proposal outline. It was going to be a pretty standard technical proposal stressing our win strategy themes which would be written by our design sections. This would be supplemented by appendices that John Taylor usually wrote predicting the radar's performance in weather, severe ground clutter and jamming. Our systems engineers would back him up with data and scope photos from sites around the world, including the Swiss ARSR-3 sites in their own country. He asked me how I felt about beating Hughes. I said we should blow them away. I said I'd rather be riding our radar than theirs. He said I would too. But I don't see anywhere in your outline where you're going to tell the customer that your architecture is superior to theirs. I said I guess we take it for granted. I've heard some criticism from some high level Wx managers about our stacked beam architecture being old technology and such. He said the term stacked beam has been around for a while. Your competition will hammer away at you trying to convince the customer that an electronic scan architecture is superior to your older approach and no matter how sophisticated you think a customer is, there will always be two camps. So why not refer to it as multiple beams. I said we do. He reminded me that there are only two ways to compete with a multiple beam radar. One way is with another multiple beam radar, and the other way is with multiple radars. Then we modified our win strategy. All of our other items were secondary to our main theme - beat the Hughes pencil beam radar's architecture. It turned out that we had to win that battle several times in the future. It was often difficult to explain why a single pencil beam was not as proficient as a multiple beam system. I would usually start by saying on a clear day you can see forever. But a pencil beam radar facing the ground clutter, weather clutter, and jamming found in a tactical environment is seriously flawed. It has very little opportunity to gather the data needed over that short period of time to process all that clutter. Once the beam scans past a point, there is insufficient time to dwell or scan back and data is lost and in radar there is no substitute for lost data. A

multiple beam radar is nearly equivalent to multiple radars and no time is wasted scanning vertically. The system is not overwhelmed by the environment but instead uses all of the data to enhance its capabilities.

Hochheiser:

Right.

Meren:

So now Jack and I felt we were in a stronger position to win. Nick stayed with us throughout the proposal period and although he flew back and forth to California a few times, he reviewed the final draft of the technical proposal. We would sometimes have dinner and he was a nice person to be around. I really appreciated what he did for us and for the opportunity it gave me to work with him. I told Jack that he had made a good move to get him and also that I wouldn't like to compete with him.

Hochheiser:

Right.

Meren:

I wrote very little of the proposal but reviewed all of it. Guntis was now reporting to me and managed the technical volume. I met with our antenna experts and we focused on preparing what was needed to get our export license approved. There was nothing to guide us in the international acquisition regulations, the ITAR. We were starting from our reflector side-lobes of 23 dB. The ULSA was much better than that and so was the AWACS, but we felt that we could get approval for an export level of 35 dB. We had exported everything else in the radar at one time or another but this was the world's first ground-based ULSA. We had no way to find out how that level would be received by the approval board, but we did find out what they were concerned about. And that's what we went down to try to get approved.

Hochheiser:

Of course.

Meren:

During that period, we had been told that the board would not approve the sale of any military hardware to a country if either they, or if captured by the Russians they, could reverse engineer it in less than five years. And we were seeking approval to sell a state-of-the-art antenna to a country with a history of reverse engineering. Most notably, the Swiss had reverse engineered the French Mirage and sold the information to Israel. Coleman Miller put our request together, and Gary Evans and I met with the board in the Pentagon. I described the differences between the system they had approved for our tests in Switzerland and what we were proposing. I linked all of the new hardware to other cases they had approved for us and then said that Gary was going to describe the antenna. Gary walked through the entire design process in a very understandable way. He talked about how long it had taken to develop the computer aided design of the antenna ending with the required precision to which the slots in the waveguide had to be machined to achieve the overall antenna performance. Then he swung over to the derivation of the tapes which manufacturing would use for their numerically controlled machines and finally told a similar story about deriving the test tapes used for pattern testing at our antenna range. He showed that the design, production and test phases were so intricately connected that anyone wanting to reverse engineer our design and duplicate its performance would have to reverse engineer our entire CAD, CAM, CAT and test range to do it. Gary sat down and the first question came from the USAF member. What are the side-lobe levels you want to export? I said 35 dB. I added, for the benefit of the agency member concerned about reverse engineering, by the way, that's the level that would be achieved by anyone if they could reverse engineer it. There were no more questions and we left. Our approval was quickly granted.

Hochheiser:

Right.

Meren:

We submitted the bid and I continued building an engineering organization to support the Tactical Radar Department. The people now reporting to me were the engineering managers assigned to each of its programs. In addition to those I mentioned that we were designing for Morocco, we booked an 18 lot of TPS-43s for the USAF, two for Thailand and six for Pakistan. We also booked 15 AN/TPS-63's and two-65's, their dual version, and then we won the Swiss TAFLIR for which I named Ken Horenkamp EM. Early that year I met with Jackson and he said he was going to retire. He told me why and that his reasons held when Harry Smith asked him to reconsider his retirement. For most of his time as our leader, the margin on Jackson's foreign programs made the bottom lines of his superiors look very good. Additionally, he funded most of our development

needs. Since I had to interface with a lot of people, I never got into high-level political brawls, but I was usually made aware of their outcome. I knew how important our international business was to everyone, so when I was asked if I would travel internationally, I agreed. Milt Borkowski, who had been added to Maurice Ani's staff, took over as manager of surveillance radars.

Sometime after we won the TAFLIR contract a program decision was made to use a version of the F-16 programmable signal processor on each beam in place of the four-pulse MTI canceller approach we had proposed. This had been suggested by Harry Smith as a way to improve the radar's performance in clutter. I had once asked for a comparison of the two approaches and was told that it was like having an eight-pulse canceller with a much better improvement factor. In any case, there was no doubt that it would significantly improve our radar. But the net result was that it became a much more complicated processor to design. It also gave engineering the opportunity to imply that its over-run was due to Harry, although I don't think anyone ever told him that. Only Milt's controller and he knew how much of his margin he applied before the bleeding stopped. The real beneficiary was the customer. When they first saw the radar operating in Switzerland their jaws dropped because this radar could unmask a jet from the Alps. I've never heard of a radar that could come close to doing that. During that year we bid and won the ASR-9. My contribution was limited to participation on the proposal review teams, Blue, Red, and Gold. We won the contract for the production of the 137 radars you can see at every airport.

International Travel, German ASR-9

Also during 1980 I went on five international trips. Bill Baumgartner was Jackson's manager of advanced programs and continued in that role. He had retired from the USAF and knew most of the Pentagon desk officers and their countries of interest. He also worked very closely with our network of international marketers. Before I visited a country, he would loan me his file which included descriptions of the customs and courtesies of the countries I would be visiting. He would select a travel window and get pre-approval for my trip so that both Milt and my GM, Hank Airth, knew where I was going. Later, this process got more complicated due to the clearances I had and the places I was planning to visit. On my first trip, I visited the Brazilian Air Force Development Lab in San Jose dos Campos. They were interested in co-producing an S-band radar similar to our ASR-9 but wanted to start with the antenna which Cal Jones who was with me handled. The head of the lab asked me to look at a radar they were designing. Everything had been crammed into one cabinet, nothing was shielded and so on. I suggested that they separate the subsystems and get them working before putting

them together. I wanted to tell them to start over but I was hoping they would conclude that themselves. Soon after we left, their antenna program lost its funding.

Next I visited the UAE [United Arab Emirates] with Homer Willett, our OPS analyst who was also a retired USAF Colonel. I described the AN/TPS-43 and our tactical air defense and communications shelters. I had brought scope pictures which showed the results of processing the data through our digital target extractor and tracker. Then Homer showed them how to set up trial intercepts. He then described how we would extend the performance of a TADS to a countrywide automated air defense system. Although we soon got the contract for the TADS which included the TPS-43 radars, it took seven years through four changes of command before Bert Drummond booked it during a long in-country visit.

On my way back I stopped at Munich. George Martin had a request for an ASR-9 briefing from the German Air Traffic Control Organization. We had just won the program so my visual aids were the schematics, drawings and charts the team had prepared for the proposal. I also had a copy of the proposal and the cross-reference index that I had prepared when I helped [the] Red team [with] the proposal. George had set up the meeting in a conference room in a hotel where he was staying. George and [the] ATC manager met me in the lobby and we walked around to the conference room. Both sides of the table were lined with engineers, seven on each side. Each one had a copy of the FAA ASR-9 specification in front of him. Their manager introduced me and then said he had hoped that his people could have some points in the spec clarified and had come prepared to ask questions about their specialty areas. And I told him that I had come prepared to brief your group on our winning approach to the ASR-9. But since I was one of the people who reviewed our proposal to ensure its compliance with the spec and since I have a copy of our winning proposal with me, I can tell you how we satisfied the requirements. I don't want you to think I'm an expert in all of the areas but I feel that the engineers who wrote our response are. We actually went through every page of the spec and stopped whenever an issue needed clarification. As we discussed an area I would put up a related vugraph. It took almost two hours but there were no snags. Then I said does anyone have any other questions, and one of the engineers asked what are the prime power requirements of the radar? I thought about it and said I don't know. No limit is given in the spec and I'm not sure the FAA cares since the ASR-9 will replace existing radars that are not as efficient. But we'll send you an answer when I get back. It was just after 8pm. George had ordered a buffet type dinner in another nearby room for everyone. Some of the engineers wanted to know why I had learned so much about FAA specs and I said self-preservation. I told them that the FAA was one of the most demanding customers we ever had, but look at the results. Later George and I met with our host. I started by asking him if could review a few potential business

approaches with him. He agreed so I started with a sole source award for radars which would meet all the requirements of the spec we just reviewed. Next, buy the radars directly from the FAA and take full advantage of their logistics pipeline and training. Next, re-issue the ASR-9 spec exactly as written and let us work with the FAA to help you realize the savings for you. Then he said I had to make this a competitive procurement. I asked why. He said the agency has heard from other countries that want a chance to compete but we have heard nothing from the US. He had tried to use the same reasons to convince his management but their only concession was that he could release the ASR-9 spec for their procurement. I asked him if he would tell me which countries came in through their embassies. He said Italy and France. I said I'm sure you know that neither of their radars can come close to meeting the ASR-9 requirements. Both companies are still using magnetrons as their output tubes. He said yes, we do know. He thanked us and left no doubt in our minds that the job was ours to lose. After I wrote my trip report, the ATC programs office contacted the FAA Foreign Liaison Office and asked for their support. But the RFP was issued and a proposal was prepared.

In the meantime, I travelled to Taiwan and Thailand to brief each Air Force on a mod we had made to one of the Korean TPS-43s. They had asked for help detecting small aircraft incursions across the demilitarized zone. We had borrowed a 5KW solid-state driver from our production line and transmitted an L-band beam through the beacon antenna which was chin-mounted on the TPS-43 antenna. This very simple mod gave us a look down capability that worked for the Koreans and was of great interest to Taiwan and Thailand. During the summer, our ATC programs office submitted their proposal for the German ASR-9s. By late August we were told that we had lost it to HSA, the Dutch Radar Company now owned by Philips. I was scheduled to attend my first air show at Farnborough, UK. The winner of a large air defense program, the UKADGE, was scheduled to be announced during the week of the air show and Maurice Ani planned to attend to receive the decision from the Ministry of Defense. Milt and I returned from the show together and went up to our hospitality suite in the Churchill Hotel. When I walked in, Maurice motioned me over and said Lou, I'd like you to meet Lord so and so, the managing director of Marconi. We shook hands and he left. Maurice said, do you know what he said to me? He said, pity. He saw Milt come in and when he came over he told him what had happened. And that was how he found out we had lost a huge program. We both told him we were sorry and later agreed that you couldn't help but admire him for the way he took the news. It was demeaning to begin with, but to be informed by your competitor on your own turf while he watched for your reaction took competition to a new low. Later that night he introduced me to the CEO of HSA. He told me that he had asked him if he would let his engineering manager debrief me on their win over us in Germany and he said yes. I said will he tell me how they won and he said sure.

The next day he asked me to go down to Morocco to see whether or not I was satisfied with the way things were going. He told me that John Stuntz, then Harry Smith's deputy, and our program manager Bob Cowdery, were on site. We had sent Paul Kennedy and a team of engineers to Morocco to get the equipment ready for customer sell-off. After the air show I flew to Morocco. I reviewed the status of everything we had designed for the program and Paul's problem book and file of changes. Most of the delay was due to overheating in the solid-state modulator for the TPS-43. But a fix was being designed and would soon be implemented. I told Paul that I was still concerned because we hadn't seen this problem on the ARSR-3 and he said he already had our engineers at home analyzing it. I asked Paul what he needed and he said some sleep. I spent the next day at the site while the engineers were uncovering problems with cables, grounding and crosstalk, nothing that hadn't been seen before. Paul and I met with Bob and I told him that I was satisfied that things were under control. I didn't have to say anything more. Bob, having managed the AWACS program, knew how to get attention. That evening I flew to Amsterdam. The next morning I flew to Hengelo, HSA's headquarters, in the CEO's private plane which he sent to pick me up. That was the most colorful flight I ever took. We flew at low level across miles of tulips in bloom. Their engineers told me that the changes they asked the German FAA to make were carefully selected and fit into two categories, those that would cost us money to remove, and those that would cost us money to implement, all the while moving toward their proposed design. Then they prepared the sequence for submitting the change requests and reviewed each set with the customer. They said they were amazed that we never complained to the customer. They showed me around their facility. Most of their production was for shipboard use. But their management had decided to penetrate the ATC market and this was their entry. They were rightfully proud that they had knocked us off. I sent some brief memos covering my visits when I got back.

A month later I visited Cairo and briefed the TPS-63, and the tactical ops and communications shelters we had developed for Morocco. Most of the time when I briefed the -63 an antenna question would be asked - usually, why is it so tall? Then I would show the sharp cutoff on the underside of our beam on a coverage diagram and its effect in detecting a small target near the deck overland or a sea-skimmer over water. That's what sets this radar apart from radars like those you have or from any other radar in the world. Their present radars were supplied by the Soviets, and our major competitor was Thomson-CSF, the French company. I then flew to Bangkok and briefed an auditorium half-full of Air Force officers on the dual-band radar and -43 improvements we could make to those they already had. Bangkok is half way around the world from Baltimore so I flew east when I left and made my first flight around it.

Hochheiser:

So you were in that slot for about a year.

Meren:

Right.

Ground Radar Department, Yugoslavia

Then I took over as Engineering Manager of Milt Borkowski's Ground Radar Department. The ATC business was added to the tactical radar business. Six months later, the defense business unit was reorganized into numbers of divisions. Milt was named general manager of the surveillance radar division to which our Navy business was added. It became one of three divisions managed by Maurice Ani. Over the next 13 years, through an average of a reorganization a year due to the usual corporate executive attrition factors, Milt's objectives and responsibilities continued to expand. When I retired, Dick Linder had been president of the Electronics Systems Group and Milt was VP [of] Command Control Communications Intelligence and Marine Divisions. Throughout that period I was his engineering manager. Milt managed the Surveillance Radar Division until '86 when the Command and Control Division and the Communications Division became his responsibility. During that time I travelled to most of the countries on the list I attached to my resume.

Hochheiser:

Oh, you mean that list of countries you went to?

Meren:

Yes. My first trip to Yugoslavia resulted from an interview with Phil Klass of Aviation Week Magazine during which I discussed the ULSA. At the time, the State Department had approved the USAF letter of agreement, LOA, authorizing the sale of five AN/TPS-43 and eight AN/TPS-63 radars to Yugoslavia. Since it was to be a foreign military sale, the USAF was responsible for the export license. The Yugoslav Air Defense Commander, General K., after seeing my name in the magazine said he wanted me to brief him before he signed the LOA. Bill Baumgartner and I met with the USAF desk officer in the Pentagon and the meeting went to another level. We were joined by a high level civilian employee from the ESD, the AF system's command and others. We learned of the possibility of later becoming involved with their air defense system. The existing system

inside one of their mountains used Marconi equipment and was out of date. We were told to assume that everything we said would be overheard and that everything was bugged. Our meeting in-country was held at Air Force headquarters in Belgrade. I described, through the General's interpreter, the version of the radars contained in the LOA. When he asked me to describe the ULSA antenna, I gave him the briefing I had cleared at our Pentagon meeting before the trip and he told the USAF that was the antenna he wanted in the LOA before he signed it. Our USAF Colonel told him that since that version of the TPS-43 was not yet in USAF industry it would delay the program until Wx could design the resultant system. We left and walked to the American embassy just a few blocks away. We met in the conference room where we would discuss anything related to the program or business, either Wx or USAF. We asked the USAF Colonel if he could get ULSA export approval to Yugoslavia. He thought the State Department was eager enough to see our hardware in that country that they would approve. I asked about increasing the baseline price and he said he would work on it.

When I got back, I met with Gary Evans and told him that we were going to need an ULSA. He and Coleman had obviously talked about it while I was gone because he said if you need 35 dB side-lobes again we can eliminate the fold. So the antenna without the fold that is right out in front of this museum was first designed for the Yugoslav Air Force and became the TPS-70 export standard. As I blocked out the rest of the system, I chose the most advanced hardware we had already developed which for the most part became that from the Moroccan program. The array signal processor which would perform the digital target extraction and the track functions were by now standard hardware. An ASCII keyboard had been added to the display making it programmable. I received cost estimates from the design managers and from the C&C logistics support general manager, Tom Mercer. Tom was great. We had worked some cost related issues in the past. I told him that their commanding general ordered that his Yugoslav Air Force officers would be trained by our design engineers and that they in turn would translate their knowledge into Serbian and train their people. Further, we would not have a field engineering and services team in-country. I told Tom that we needed to apply any savings realized to the radar which would become the next generation TPS-43. Next, I asked Dick Koehler who was now manager of TPS- 43 programs to ask the Saudi Arabian customer to convert the two TPS-43s they had just ordered to TPS-70s. When I met with Milt I showed him that despite everything everyone had done, we still needed a larger lot size over which to spread our development costs. I said I thought we would need at least five more. Milt approved and later, when Dick Koehler released the first TPS-70 production lot, it was for 13 radars, five of which we had not yet sold. This was how Milt invested in us. He would get estimates from marketing of the number of radars they expected to book worldwide and take a percentage of the total and release

that number to manufacturing. That sounds easy, but it could very easily become a career-busting opportunity.

His was the first executive management position in the corporation which had a profit and loss statement or if you prefer, bottom line. And that was mainly derived from the summation of the financial performance of the contracts within his area of responsibility. This was the method of the operating divisions. Our development divisions were allowed to break even and each of the operating divisions were taxed to help them achieve their break even status. I know I've dwelled on this subject, but from this point until I retired, I was Milt's engineering manager. Administratively I reported to the general manager of our development division and dotted line to Milt except at the end of my career when I became a direct report. Since this was a new radar, it was a little difficult asking him to do it, but nowhere near as difficult as it would be for him to approve. But it was the right decision. As we were working to change the Yugoslav TPS-43 to a TPS-70, the TPS-63 was allowed to go forward by itself. But it wasn't going to be by itself. At our last reorganization, Navy radars became Milt's responsibility and Jim Luck from that group became TPS-63 program manager. He successfully combined the needs of Yugoslavia, Egypt and Korea into a single 24 lot of radars, each country to field eight. This was a great boost for a great radar.

NATO Air Defense Ground Environment, More Travel

In mid-'81 I travelled with a consultant who had been retained to review the study report for the upgrade of the NATO Air Defense Ground Environment. The study effort had been managed by George Martin who had moved to Brussels for its duration. The consultant was Lt. General Karl Petersen. He had been the commander of NATO North and spoke Norwegian. We met with the Danish Air Force Chief of Staff and a few radar officers and I briefed them on our TPS-70 and TPS-63. This was before NATO purchased the AWACS and side-lobe levels, decoys and anti-radiation missiles were all topics of interest to them. When we visited Norway, I briefed the Chief of Staff of the Air Force and his staff. Many were probably there in deference to Gen. Petersen's former position in NATO, but it was the most star-studded audience I ever faced. Jim Bradley flew up for the meeting and said there were 37 total stars on the sign-in sheet. I also visited the NATO SHAPE Technical Center in The Hague headquarters in Mons, Belgium and the Spanish Air Force facility in Madrid. I had only taken a few vacation days in 1980 and my wife and I started planning a trip to Europe for September, after our daughters returned to college. We planned to visit Dublin, Bruges, Salzburg, Rome and Madrid. We planned an average of three days in each country with all travel by air. Within the next month, Bill Baumgartner received two visit requests for me. When Hank Airth asked me if I wanted to fit them in I agreed. Then within the next two months he received five more requests

including one from Yugoslavia which I had to attend. Hank asked me what I wanted to do and I told him that since my wife had been looking forward to her first trip to Europe I didn't want to disappoint her. I gave her the option of meeting me after I finished my visits but she didn't want to fly alone. Besides, she liked the new itinerary so I told her I would ask for permission to take her on what was now a business trip. Hank said in that case, we'll pay for her to go.

On that trip, we flew to Frankfurt then to Salzburg, where we spent three days which included a day trip to Vienna. Then we flew to Bonn. Mac McConnell - from our Wx office in Bonn - and I visited the U.S. Army base at Darmstadt to discuss the results of some work that one of our systems engineers, Joe Henry, had done for the Army at White Sands. Next came a one day trip to Paris. Although the French were part of NATO they often requested private briefings at their headquarters. We arrived in the morning for a 10am meeting after which we had the day and evening to ourselves. When my wife changed for dinner she changed purses and left all the jewelry she wasn't wearing hidden in the bottom of her larger bag. The next morning when we were getting ready to leave for Belgrade we realized that we had been robbed. I reported the theft to the hotel management and to the police. Mac stayed with it until his early afternoon return to Bonn, but it was lost. Belgrade, Brussels, The Hague and finally Bern, for a meeting concerning a Swiss military ATC requirement were our remaining stops. We had been gone for 23 days.

The night before we were scheduled to leave Norm Molz, one of our international marketing managers, called and asked me to meet him in London on my way home. We met in the embassy of Pakistan and I was asked to visit a number of places in Pakistan in the following month. So on our trip we actually visited the capitals of eight countries and had a memorable vacation. I was later surprised that my homeowner's insurance covered the loss. A month later Norm and I flew to Pakistan by way of Saudi Arabia. During that trip, Norm and I visited Air Defense Headquarters and they asked me to visit their military airfields near Islamabad, Peshawar and Rawalpindi. Pakistan had purchased F-16s and later six TPS43G radars. But their airport radars were older gap fillers made by a German company. At one base, an officer asked me what I thought about his radar. I said it was nice. Then I said we're near the runways and I can hear planes taking off and landing but I can't see them on the display. This is a 45 kilometer range radar but you have blanked the first 30 kilometers. He said we have a lot of clutter so we tilted the antenna up. When we returned to headquarters I told the Air Vice-Marshall that they were using a radar for air traffic control which had been designed for a different mission. I briefed him on the ASR-9 and the TPS-63. Before we left we met with our defense attaché in the US embassy. Part of his job was to be aware of Pakistan's military air

traffic control capabilities in the event that they might one day be needed to control USAF military aircraft and I briefed him on our visits.

Surveillance Radar Division, Tokyo

Hochheiser:

It's 1982 and you're now Surveillance Radar Division, SRD, engineering manager.

Meren:

Right. Milt organized SRD into departments and each department proposed and then managed programs that they booked. Each proposal had a proposal manager and each program had a program manager. In both cases I would assign an engineering manager. As the business grew I planned to assign an engineering manager to each department but until then they reported to me. At the time, the ATC department was designing the ASR-9 and the mode-S systems. Tom Dovey and Bob Fowler were the EM's reporting to me. Each managed a large team of systems and design engineers assigned from their functional groups. Similarly, the EM's for the Tactical Radar Department continued to report to me. These included all versions of the TPS-43 and TPS-63 and the Tactical Air Defense Systems, TADS, elements. These could handle the needs of small countries like Mexico for example. We had also begun selling our TPS-63 LASS aerostat radar. The Navy business that was transferred to Milt included the SPS-58/65 and the W-160. This was an application of the F-16 fire control radar for use aboard ship as a surveillance radar. To accomplish this, a new antenna was required and the processor required re-programming. It was a fixed price development contract for Taiwan. That design took its place among the more difficult radars we had to design. We were having a lot of difficulty with all of the software intensive systems we had under contract. The software system architects we had were very sharp, but we just didn't have enough of them. Ben Vester called me and said you guys are going to take a bath on that job. I assigned Dick Schurmann as EM and he prevented that from happening. He practically willed that radar into existence using whatever part time help he could get. The engineer who helped him do it - and who took the systems to the field and sold them off - was Buzz Kalafos, VP of surveillance systems for Northrop Grumman.

In February of '82 I was scheduled to visit Taipei for a dual-band radar briefing. Bill Baumgartner was scheduled to visit Belgrade to review the revised LOA in behalf of Wx but could not go due to illness. So I went to Belgrade, then to Taipei. I was back in April and signed the LOA in behalf of Wx and soon after that we got the contract. Then the TPS-70 was designed and Dick Koehler released the initial production order for 13

radars. A couple of years later Milt said he considered me the father of the TPS-70 and admired the way I fashioned the program into a 13 lot. But he's the guy whose neck was hanging out. In June, Joe Henry and I visited the NATO office in Paris. We left DC on a Thursday night. The French were interested in upgrading their Hawk radars. I briefed the DSP and Joe briefed the Hawk ULSA. He had led the system's engineering effort when we sold the ULSA development to the US Army. Joe planned an overnight stay in Paris before returning to Baltimore, but I left that afternoon for Rome. As we left we were stopped as a motorcade under heavy security sped by. One car held President and Mrs. Reagan. The next day Jim Bradley flew to Rome from his London office. He had arranged a meeting with Selenia Management for the next day to discuss teaming to bid an Italian Air Force requirement. Our hotel was next to the American Embassy on the Via Veneto. The next morning, the area was swarming with armed guards and the street was barricaded. We crossed the street to wait for a Selenia driver to pick us up when a motorcade left the embassy. They turned left about five feet in front of us and this time we got a wave from President and Mrs. Reagan. Jim said I should have asked him for a ride to Rome. The last leg of my trip took me to Tokyo. I was scheduled for a first class flight, Rome-Bangkok-Tokyo, on Japan Airlines. When we leveled off the pilot welcomed us and said that our first stop would be in Moscow. I asked the steward why this flight wasn't going to Bangkok as stated on my ticket. He went into the cockpit and returned and gave me a copy of the flight plan in Japanese showing Moscow. The pilot told him that the route had been changed two days ago. So I sat back and enjoyed one of my best flights ever. The appetizers were a combination of Italian, Russian and Japanese delicacies and the meal and drinks were outstanding. It certainly compensated for my trip to Pakistan where I had contracted food poisoning and lost 15 pounds.

I spent a lot of time being debriefed when I got back. I was going to meet George Shoenberger, Milt's ATC programs manager in Tokyo. George would describe our ATC programs and I would give technical briefings focused around their requirements. By this point in time we had charts which compared our performance to that of every other ATC radar in the world. No other country specified more stringent performance than the US FAA. In short, that was the primary reason why we were often getting hammered by the French and Italians in some countries. Japanese radars shared common design threads, none used solid-state technology, all used magnetron FPA transmitters, and performance in rain, reliability and maintainability requirements were hardly ever specified. So nearly every technical strength we had designed in our radars turned out to be a huge burden to us in the international marketplace. So obviously it was important for us to be aware of emerging requirements and work to cultivate customer interest in us. I mostly focused on the technical aspects while our programs and marketing took care of the rest. I had met with Milt before I left. We knew that Mitsubishi was about to start designing an L-band long range active aperture array

radar for their self defense force. It had been a sole source award. We had talked about the future impact on our business if they pulled this off and tried to work out ways that would involve us. His idea was to offer Mitsubishi the opportunity to co-produce any part - or if necessary all - of the ASR-9 in exchange for allowing us to co-design the SDF radar. At the meeting I gave an overview of our long range L-band radars and described the evolution of our solid-state MICS. After I described the ASR-9 and told them what our offer was they asked for a brief caucus. When they returned they said they were very interested and would call us after meeting with their customer.

Taiwan and Korea

In July, six of us visited Argentina after their Falkland Island War with the Brits. Milt and I, accompanied by Guntis, Jim Luck, Chuck Sprague and Paul O. from ILS made up the team. The Brits had captured one of their TPS-43s, had damaged two others and destroyed one antenna. When they asked for help, the USAF told us that we could only restore them to their pre-war position and provide spares and training so we did that before the end of the year. We had also wanted to discuss their emerging requirements for a tactical air defense system which we all participated in. In September I visited Taiwan Army headquarters at the north end of the island. They wanted a detailed technical briefing of the Hawk DSP before they were going to place their order. Further, they wanted the briefing to be in Chinese. JD Brown, our long time manager of our international defense marketing office hired a professional interpreter and we took off. Things were going pretty smoothly until one of the radar engineers in the audience asked a question and the interpreter answered it without interpreting it for me. That triggered a comment from someone else but before he could answer I said stop, but he didn't so I walked over in front of him and covered my mouth with my hand. When he stopped talking I told him not to do it again or I would tell JD not to pay him. I went back over the vugraph that had started the side discussion and we finished up without any further incidents.

My last trip in '82 was to Korea. I was scheduled to meet the Air Defense Commander whose approval of the dual-band radar was required. When I got to his office he greeted me and said I know why you're here, but I don't want to talk about anything until you tell me when the rest of my TPS-63 radars will be installed. I said is there a problem and he said no, your first radar was not commissioned yet but during tests it was the radar that detected the Chinese MIG flown by a defector pilot which landed here in Seoul. I called Jim Luck at home and he told me he would call me back with the schedule. Late that night, 11am in Baltimore, Jim called back and told me the next three radars were hung up in Korean customs and the installation crew is standing by. The remaining four radars were on schedule to be shipped before the end of the year. The

next morning I told the general and he called his aide in and rattled off some orders in Korean. Then he thanked me, listened to my briefing and said he wanted his TPS-43s converted to DBRs. Some countries have a very short chain of command. I was told that this general reported to the president. But with all that clout, Jim Luck told me that it took him three weeks to spring his radars.

Meanwhile, some work we had done for Jackson looked like it was finally going to pay off. We had borrowed four 6kW solid-state drivers from our production line and combined them to form a 25 kW transmitter. We demonstrated a long range version of the SPS-58 to Taiwan and they became interested enough to develop a requirement. Our Navy group later bid and was told that they were going to get the job as soon as some mods they wanted were incorporated into the spec and one of our systems engineers agreed to make the changes. After the job was transferred to Milt he wanted his controller to review the bid which was firm fixed price. The design managers and the systems engineering manager were asked to review their quotes and the only portion that stood firm was the solid-state transmitter. The changes had caused higher quotes from all other areas. Then Milt came into my office and told me that because of all of the cost increases, the price that was quoted for eight radars would now only buy them seven. Since our bid has expired I want to get out from under this contract. I would like you to go to Taiwan and tell the Admiral. I said you want me to go with Darryl - D. Karl - our program manager. Milt said yes, Darryl will be there but I want you to tell the Admiral. I said you know I'm going to be persona non grata in Taiwan after that. He said I know, but I need you to deflect the heat off our programs. So how about right after New Year's (1983) and I said okay. When I got to Taipei I checked in at our office. I learned that Harry Smith, Maurice Ani and Art Monheit had accompanied Bernie Harris to his presentation of the study results of his Taiwan frigate program. The Admiral I was to meet with would be among the other admirals in his audience. That night, Art asked me to come to his hotel room. He said he knew why I had come and asked if I would please wait until after their meetings and I said sure. I had been talking to Darryl, who knew the Admiral, while trying to develop an approach. But it was not until I talked with one of the marketing people in our Taipei office, a Wx employee and a retired Taiwan Navy Captain, that a plan evolved. I told him why I had come and he said oh, that's very bad. He said the best thing that could happen is for the Admiral to know the story ahead of time so that when you tell him he will choose his reaction to not lose face with his staff. I said I thought we would meet in private. He said no. You must have his staff present so they can see his reaction. I said okay, how do we tell him ahead of time? He said I can help if you agree. At one time I reported to the Admiral. We are very good friends and neighbors. This weekend we will have a barbecue in my back yard. After that, I can tell him. I said I agree. So the meeting went as planned. The Admiral chose to react calmly and said he was sad that we had let him down and although he preferred

the solid-state radar we had demonstrated and proposed, he was going to buy the tube type radar that HSA proposed. I did not visit Taiwan for 14 months and when I did I was on vacation with my wife. She had wanted to visit the Orient for a long time and I took her to Tokyo, Kyoto, Taipei, and Hong Kong. I thought she had shopped herself out until we hit Hong Kong but she had only begun. I never asked her how many cashmere sweaters she bought for our family and friends. Years later, Joe Redmond told me that the Admiral had been jailed after being found guilty on a corruption charge.

Finland and Norway

Over the next year I made two trips to Turkey to help them solidify their long range radar requirements and a trip to Norway and Finland. I had met an officer of Finland's Air Force at an earlier air show and told him that he would need an export license to get a detailed briefing. Three months later I got a letter from a manager of a Westinghouse office in Helsinki saying that the Air Force had asked him to invite me for a briefing. After hearing their requirements, I told them that the TPS-63 could exceed many of them. As I described the radar I showed display photographs to demonstrate the improvements that each stage of processing provided as it was switched in. They all said they liked the radar and before I could ask they said they would have to complete the radar. I asked if they had anything in their procurement regulations that would permit the direct purchase of off-the-shelf hardware. They said yes, but they had been told that a copy of their requirements had already been delivered to the embassy of another country. I thanked them for inviting me and for their openness.

The meeting in Oslo was held at the Norwegian Defense Research Establishment. I had not been told what the subject was. The meeting was held at one of NATO's classified levels. A diverse group of people had been invited. A few months earlier I had read that a helicopter had crashed in the North Sea on its way to an offshore drilling station. The article described their air traffic control system as consisting of the pilot reporting his position every ten minutes or so to provide a rough idea of his location for air/sea rescuers. I made a casual comment to a member of the SHAPE Technical Center about how they could use our TPS-63 out on the tower and at this meeting I was asked to expand that idea. I showed our range coverage on a map of the area and the elevation coverage with the radar on the tower. The ATC and air/sea rescue people were interested in coverage over flight paths and NATO and other people were interested in coverage looking North. There, the radar would be looking at a slot used by both air and sea forces of the Soviets and that is how the requirement emerged. The NATO people knew about our TPS-63 thanks to the US Marines. They had participated in a NATO exercise during which they deployed a -63. I got a call from a colonel after that telling me that the radar performed perfectly which was important for that mission

because they showed up without any spares. To handle the program as an ATC requirement, Shell Oil Company would fund it. When I got back I met with Jim Luck and he assigned both programs to Wayne Schatz. I told Wayne that the Finns really wanted us but that we were probably going to have to go through Ericksen, in neighboring Sweden, to win. Unfortunately, that happened. And to my knowledge, no one has ever mounted a radar on an offshore drilling platform. The petroleum engineers and rig managers that I met were hyper-sensitive about any source of radiation or opportunities for high voltage arcing or sources of sparks. In the end, Shell Oil pulled their support and the program was killed. A last ditch effort to put a radar aboard an aerostat tethered to the tower also failed.

TPS-70 Internationally, DIVADS

In November of that year I visited Oslo for a debriefing then I met Milt in Munich for a meeting with Siemens who wanted us to upgrade their short range radar with a solid-state transmitter. There was little in it for us and Milt declined. Most of my time in Baltimore was spent managing engineering for the Yugoslav TPS-70s and the TADS shelters. Some time earlier I got a call from George Michel who was managing the DIVADS Program. He had just demonstrated the system to Ben Vester and Ben told him to run through the demo for me. It was an impressive system. I was also impressed with the test environment George had created. I asked him if it was covered by the contract and he said no - he had requested capital funding and everything he asked for was approved. Also during '83, the Brits obtained an export license so we could help them refurbish the radar they captured in the Falklands and make it operational. We had sent an experienced technician with data and spares and he got it playing. Soon after that, the radar at one of their military airfields failed and we got a call asking whether we could send a crew to help move the -43 to fill in for the failed Plessey radar. We told them that the field technician on site could do that with some help from them. The call came on Friday and the radar had been moved on Saturday and was operational on Sunday. An Under Secretary of Defense had called our London office to thank us for such a quick response and they told him that I would be coming through London to join the manager for a flight to Lisbon and Madrid. After I got to London I met with him in our office. He told me that they were particularly impressed with the mobility of the radar as well as its small size relative to other tactical radars he was familiar with. I asked him if he could spare some more time so I could tell him about the TPS-70 which was our latest derivative of the TPS-43. He said certainly and I walked him through the differences between the radar they had captured and the TPS-70. He asked if I was aware of a procurement they were planning for five tactical radars. I said no, but I hope that your experience with our radar influences your requirement. We flew to Lisbon to help develop a requirement for a coastal surveillance radar system. The radars were to

be deployed along the Atlantic. Our W-160 would be a perfect radar for this procurement but this customer could not afford perfection and didn't need the overkill that our W-160 brought. We briefed the TPS-70 to both the Army and the Air Force in Spain. Each service had bought our TPS-43's.

In March my wife and I took the vacation trip to the Far East that I told you about. Then in August we took a vacation trip to Europe that I combined with business. We flew to Brussels for a meeting George Martin wanted me to attend [for] Red Team, the sensor section of the study program he was managing. Then George and I flew to London for one day of the air show and meetings with his customer. We returned the next day. I picked up my wife and we drove to The Hague. After a meeting at the SHAPE Technical Center we spent three vacation days in Bruges and Brussels then flew to Rome for the weekend where we were joined by Milt and his wife Janice. On Monday we flew to Belgrade. I was scheduled to introduce Milt to the Air Defense General who had originally asked me to visit. He was also a member of the Joint Chiefs of Staff but had just been rotated and replaced by a naval officer. Our meeting was now with him. He told us that the joint chiefs had changed their priorities and approved funds for adding fire control radars to their tanks. They said their preference was the radar Wx had developed for the US Army, the DIVADS. Their alternate source was a K-band radar produced by HSA, the Dutch company again. I called Bill Baumgartner and he immediately started working on the approval process. When we left Belgrade, Milt and Janice flew to Switzerland and Nancy and I finished our vacation in Salzburg. Back at work I found that Bill and a lot of others had hit a brick wall with the army. We agreed to sanitize the radar and delete any function the army wanted to remain classified. When we addressed their technical concerns they would bring up some political issue and we would encourage them to check with the state department. Without the army's approval, we would not get an export license. No one knew how to break through the refusal to let us sell the radar. The process dragged on until the customer placed the order with HSA. We had lost but there was more. Soon after our episode the DIVADS program was cancelled.

Proposal Activities, China

My three international trips in '84 fit between my management proposal activities. We responded to a USAF requirement and won the Phase 1 Seek Igloo contract. GE won a parallel award. Dick Koehler had managed the overall proposal and I managed the technical volume. We proposed the W-2000 radar we had been developing in-house and GE proposed a version of the TPS-59 which they were developing for the USMC. Both were solid-state arrays but ours was a multiple beam on transmit and receive and theirs was a single pencil beam which was electronically scanned in elevation. Eventually,

in spite of our performance, Phase 2 was awarded to GE. But when the FAA refused to qualify their radar for either civil or military air traffic control, no additional radars were built.

I only took one trip in 1985 after a meeting with Milt and Guy Bias. Guy had managed the Jordanian Air Defense Program and I hadn't seen him in years. He had returned from a trip to China during which he had accompanied his wife Wilma and her assistant who was born in China and at first was afraid to go back. Wilma was a Hopkins PhD who taught dietetics and was doing that at various places in China. He told us that he was in his hotel one day when he was asked if he would like to visit a radar factory and that a car was waiting to take him if he agreed. When he got there he was greeted by the director of the Telecommunications Institute of China. He got his tea and tour then was asked some questions about the ASR-9. He told the director that he didn't know much about our current radars but would ask if someone could visit him who did. Earlier we had sent program teams to Beijing to discuss our TPS-63 radars but no one had been to Xi'an, the site of the buried terracotta army in the interior of China. Milt asked me if I would go and I told him that I would if I was allowed to. Then he asked Guy if he would go back with me and Bill B. Guy agreed and Bill made the arrangements. My travel request was approved. To fit everyone's schedule, the total round trip would take four days. We flew to Tokyo then on to Beijing. We spent hours in the airport before Guy managed to get us to the Wx office which was located on one floor of a hotel. Our hotel reservations had not been confirmed and the office manager had the hotel bring beds to rooms in their office complex and we spent the night there. The next morning we flew to Xi'an in an Ilyushin prop jet that we entered through the rear. The seats were so close together that it was a knees-in-the-chin as well as a white-knuckle flight. What made it even worse was the smell of fuel that permeated the atmosphere.

When we got to Xi'an, the trip was transformed into a pleasant experience. We checked into a very modern hotel managed by the Brits. We were picked up and driven to their Institute in separate cars. My escort who was also my interpreter had earned his PhD at CCNY and spoke perfect English. He spent most of the visit close by and at times I thought he was recording me. As we passed a walled section on our way to the meeting I asked him who lives there. He said the farmers. Do you see those carts? - as he pointed to some carts full of a vegetable about twice as big as a head of cabbage - that's what they grow. They are the new capitalists of China and can now afford TV. That's why you see so many antennas on the roofs. He said that in earlier days his father, who was a doctor, had been forced to work on a pig farm carrying bags of feed to the pigs that weighed more than he did. Just before we got to the Institute I said, what are you doing now? He took me completely by surprise when he answered. He said the transit receivers. I said which transit and he said yours, you know, the one you did for the Navy.

We're designing a receiver for each frequency and a refraction correction unit. I just said oh.

The director met us inside the gate and walked us in to his office. We had tea then went into a conference room with about 25 people present. Nearly everyone in the audience was dressed alike in blue denim looking outfits except for the director and our interpreters who wore business suits, and three guys standing in the back who wore black leather jackets. The director took his seat and nodded for me to begin. The briefing took about 30 minutes and questions took another five minutes. Then I gave them an overview of some of the other radars which I had been cleared to brief including our ATC radars and the TPS -63 which I told them had already been licensed for export to China. I was instantly glad that I told them that because the next question came from one of the leather jackets. He said what about the W-160 and I said no, that hasn't been licensed yet so I can't talk about it. So they left. The director never acknowledged they were there. We then spent time touring the Institute but not any design or test facilities. We got a tour of their manufacturing facility and then he took us back to his office. He said that he would be visiting the States in about a month to review three active programs under contract at that time with Hughes, Texas Instruments and Raytheon. He was very interested in the ASR-9 and would like to include a stop in Baltimore on his way home. Bill said he would coordinate that. That evening he took the three of us to dinner in a small private room in a restaurant. We had a drink and he talked to the owner and ordered the first course. It was a Mongolian fish which he served in his family tradition. He ordered each course that way and treated us with an outstanding experience. He arranged a VIP visit to the museum, built over and around the site of the buried terracotta army, for the next day. He also had our flight changed and we flew to Shanghai on a modern jet. We spent the night in the Kodak office in Shanghai as arranged by our Wx office. All of their people were traveling and their facility included six hotel rooms. Some American companies regularly shared their facilities and we benefitted from that policy since our reservations were so fouled up. On the way home, I wrote a report containing everything I thought I would be asked in my debriefing. I knew that some agencies did not like abrupt changes in travel plans, so I described what had happened and who I talked to in Wx to fix the problem. A week after I got back I met the first of three visitors. Before he started questioning me I asked him to read my report. When he finished he said he had what he needed. I told him he had the original. The next two visitors got copies and everything else was destroyed. It was easier than the time I unknowingly flew to Moscow.

When the director visited us Bill asked him if he had a dining preference. He said he had eaten American food every day of his visit and would really like some Chinese food. Bill made reservations at Chang's and talked to the owner. He told him who our guest

would be, what he had arranged for us in China and asked him to do that here. When we got there, the owner greeted us and the director ordered a Mongolian fish and many other courses nearly duplicating our dinner in China. When I thanked the owner he said to let him know if I wanted to do it again. So about two weeks later he did the same thing for me and my wife and our two daughters, except he selected the courses.

Black Programs, Egypt

Sometime earlier, Milt said we needed some black programs. He asked me to contact some managers who briefly mentioned them at staff meetings he attended and knew that they sometimes formed the basis for spin-off projects. He was also aware of some of my previous activities up to his security level. I tried and failed with two managers. When I got to work one morning I found an instruction book for a foreign company's radar on my desk with a note from one of our program managers saying I thought you could use this. I locked it away until I could decide what to do with it. Later that morning, Guntis came into my office and said that he had been at an event over the weekend at which a close acquaintance asked him a few questions about surveillance radars. He was surprised because although each knew where the other worked, they had never discussed it. Guntis said he would talk to me about it. I said call him. He asked if he could visit us after lunch. Guntis and I met him in our lobby and he introduced us to a person he brought along who had a program with someone at Wx. We walked over to my office and the first question he asked me was about a foreign radar. I unlocked my file cabinet and gave him the instruction book I had found on my desk. I said this should answer all your questions, but as you can see, it's in that language. I know about that radar so I don't need it. He asked some other questions which we could answer and some that would take some time. We said we could get together in a week and he said he would be back.

When we got to the lobby the person who had come with him was waiting there along with the manager he had been with, John Gregory. John was surprised when I shook his hand and said nice to have met you. Guntis was signing them out and they left. John said hey Lou, what are you doing with my customer? I said shame on you John, you just violated security by telling me that you have a black program, who the agency is and who their program manager is. But I won't tell anybody if you don't. At our next meeting, we gave him answers to all of his questions. We told him that a lot of his answers were available in the open literature, citing Jane's publications as an example. He said he knew that and then we knew that he had his own agenda and reasons for asking. He thanked me then started talking about how he thought he could repay us for our efforts. He told us that his division did not sponsor programs in the surveillance radar area. Most of their needs were in other areas which could be of interest to Wx. He

suggested that he could have his department managers and their section managers brief Wx on their needs at the secret level. One of the section managers he referred to was the one I met. He was going to coordinate the meeting and I asked John Gregory to contact the Wx people interested in the exchange. The meeting was held in our auditorium. Guntis and I attended with three other people. The auditorium was half-filled with people representing many of the specialists from our other divisions. Eventually we were involved in a black program from that agency, but at its peak, I was managing six different black programs for a number of different organizations. The early work that we did on L-band RF modules along with our antenna work was responsible for the award of two programs which were the forerunner of today's wedge tail radar system. For one program we were contracted to build a full-scale UHF active aperture array antenna designed for mounting atop a 747. After pattern tests the customer was satisfied and told me I could dispose of it. I donated it to Al Melvin, manager of our antenna building which I had used earlier in my career, and he hung it on the wall. We tried to apply it to a mountain top experiment in Hawaii some years later, and also to an airship surveillance application but could not use it to anyone's advantage.

I was able to borrow Jim Mims for a spatially adaptive signal processor requirement on one of the black programs I was managing. His reputation preceded him and his contribution was outstanding. It was easy to measure customer satisfaction on black programs. The customer placed a lot of trust in you, gave you a lot of freedom, didn't worry about mil-specs and paid well. And I never met a pompous individual at any level of the military or government on any of those programs.

Hochheiser:

Were you still in the surveillance radar division?

Meren:

Yes. Actually, I was the Engineering Manager of the Surveillance Radar Division for five years, from late'81 until late'86. During that time, in early 84, Milt was in Egypt to negotiate a co-production contract for 34 TPS-63 radars. They would be produced by the Egyptian company Benha. Milt called me and asked what it would cost to add a feature to the radar and I told him, but he later told me he had to eat it. Earlier we had a fly off against a French radar in their final attempt to win this business. After some low-level jamming runs, they lost. Jim Luck was now managing our TPS-63 business and he and his team spent a lot of air time between here and Cairo, along with Jack Standish who was then our Wx in-country manager, pursuing this program. After we won, Jim assigned the program to Charlie Pilgrim and he and his family moved to Egypt while he

managed it. Jim later told me that one of his daughters spent some time in Egypt as the au pair for Jack's family which I thought was a very rare opportunity for an American.

Caribbean Basin Radar Network, Management Changes

During that time we had the opportunity to compete our multiple beam radar architecture against the GE electronic scan pencil beam architecture for the Caribbean Basin Radar Network. Dick Koehler managed the proposal and I managed the technical volume. We competed the TPS-70 against GE's TPS-59. The proposal required an analysis of simulated system performance in rain and ground clutter using models included with the request for proposal. I asked John Taylor to prepare our response. I also asked him to prepare an analysis of the GE radar. We knew enough about their radar and its data processor to enable an analysis of their system using the same models. To protect ourselves, we defined their radar as a generic 3D long range radar, etc. Our analysis showed that we would meet the required performance and that the other radar would not. But we did not want to hide our data in an appendix to the proposal which might not be read. So after some word-smithing, we settled on a paragraph which stated: "Most 3D radar designs stumble fatally because they are fundamentally unable to quickly collect the vast quantities of data that are essential to provide surveillance over a large volume in a complex environment. Their data rate suffers as either the surveillance volume or the target load increases. The solution to this dilemma is either to shrink the coverage and operate with more radars, or add beams to the radar with independent receivers and signal processors. The TPS-70 exemplifies the most recent 3D radar coupling simultaneous beam architecture to the latest technology to solve the data rate problem." We also provided a cross-reference index which linked every requirement in the spec to the page and paragraph which described our response. We won the contract.

In late '84, Maurice Ani retired and Ed Silcott replaced him as Milt's manager. Jim Allen was replaced by Jack Tymann as GM of AWACS, also reporting to Ed. Then in September of 1986, Harry Smith retired, Dick Linder took over as president of the Defense Business Unit, and Milt took over as GM, Command and Control Divisions, when Ed Silcott took Linder's previous spot as GM, Aerospace Divisions. Wally Hoff took over as GM, Surveillance Radar Division. In September of 1986 the UK re-opened the competition for their AEW requirement. Jack Tymann spent most of his time pursuing this program and in December it was announced that Boeing had won by beating the British Nimrod. The UK seven lot was soon joined by the French four lot and Jack now added the production of 11 new AWACS radar systems to his responsibilities.

Hochheiser:

Okay. So what do you do now?

Meren:

I was still Milt's engineering manager, only now that his span of control increased to three divisions I managed the engineering which supported them. I added Garth Mackenzie as manager of Air Defense Systems and Bill Gretsch as Engineering Manager of AWACS programs, both in support of Tymann's Division. That was the organization I managed for the next two years.

More Proposal Work, NFR90 and NAAWS, Paris Air Show

During that time work continued on the Jordan Air Defense System, the Saudi Peace Pulse System and tactical air defense systems for Venezuela, Australia and Mexico. Proposal work had begun on the Saudi Peace Shield Program which Jack was leading. Meanwhile, in addition to delivering its backlog of ASR-9, Mode-S, TPS-70 and TPS-63 radars, several tethered aerostat radars were sold. The CARIBALL program covered needs in the Caribbean, the LASS program covered needs along the Southwest border of the USA, and LASS systems were sold to Egypt and Kuwait. The system in Kuwait provided early warning of Iraq's invasion permitting the Emir to escape. A major effort was begun trying to become a second source supplier for the Navy's AEGIS radar system. Most of us felt that we won this job. When it was announced that if the Navy awarded a second-source contract there would be a big layoff at RCA, the Navy cancelled the second-source requirement. And then there was a big layoff at RCA. I think that about then Milt developed a proposal mantra that said if you have the best technical solution at the lowest cost and promise the earliest delivery, you might win a third of the time. It was yet another way to lose.

During this time, Bernie Harris was managing the NFR90 program which now reported to me. Westinghouse was the US Navy's representative in this study to determine the feasibility of building a common NATO frigate. Bernie brought his experience from the Taiwan frigate to this project and had done a masterful job in defining work sharing among the member nations as well as among the US companies involved. But problems arose with the weapons systems. The US Navy and most of the other members wanted the NATO almost standard missile, the McDonnell Douglas Harpoon, except the French who wanted to use their Exocet. Further, the Brits wanted a short range point defense weapon system. Next a NATO staff would prepare an MOU for each country which would lead to the project definition stage. In the meantime, the US Navy issued an RFP. We bid and won Phase 1 of the Naval Anti-Air Warfare System, NAAWS. Although

conducted by the US Navy, it was destined for other navies, some common with the list of the NFR-90. I assigned this program to Bernie as well. At the conclusion of the study, it was decided that we would ask McDonnell Douglas to take over phase 2 of the program and Wally Hoff and I flew to St. Louis to determine their interest. Our only condition was that we wanted to maintain control over the sensor suite and command and control subsystems and they agreed. Wally told McD that I would be the Wx executive program manager which meant that I would have to travel to executive reviews in a number of the member countries. When those visits were added to my other scheduled trips I was going to be spending a lot of time in the air.

A summary from my travel log shows that my one trip in '86 took me to London and Madrid. In April '87, Wally and I visited Rome for teaming talks with Alenia. In May, Vic Grams, our TAFLIR program manager, and I visited our TAFLIR customer to discuss a pending air traffic control radar purchase. Our customer was the same person to whom I had described our original TAFLIR approach. The spec called for a radar that could be supplied by a number of companies. Our ASR-9 was an overkill. The Swiss can use sections of their autobahns as emergency runways by adding a radar nearby, some landing lights and links to their air defense and air traffic control centers. I described a radar that used the ASR-9 antenna and a scaled down TAFLIR transmitter and receiver/processor which could actually use modules identical to those in their spares inventory. Our customer was very interested in the common logistics aspect of our plan and said he would try to get agreement from his management to tailor the requirement to our approach. But he could not. So we no-bid. The contract was awarded to Alenia. A month later, Milt, Wally and I flew to London. We were scheduled to meet Plessey at their facility. Their limo took us south where we took a hovercraft to the Isle of Wight for the meeting. I gave our briefing, we had the meeting then a great dinner and joke and storytelling session which Wally and I dropped out of but Milt prevailed against superior numbers and upheld the reputation of the colonies. We then flew to the Paris Air Show.

One evening Milt and I were scheduled for dinner with the CEO and Marketing Manager of Alenia who I knew from prior visits. He knew that I spoke Italian, but he interpreted for his CEO. Historically this company had cleaned our clock in some third world countries. After dinner Milt asked him how he was able to bid such low prices for his ATC radars in small lot sizes. I wasn't as surprised by Milt's question as I was by the answer. He told his interpreter to tell Milt that when they got an order for their radars or other electronics from the Italian military, they would tell their factory to build some subsystems or mechanical parts for their ATC business and put them in storage. When they had an opportunity to bid a job, marketing would look at the competition and decide what they had to bid to win and that's how they built their sell price. We defined it as an illegal skunkworks in our factory. And when the word skunk was translated, he

smiled. I asked his interpreter to tell him what was meant by a skunkworks and then he laughed and nodded his head.

Marketing wanted to feature the TPS-70 at this air show and it was located alongside the Thomson-CSF tactical radar directly in front of a two story building with an overview of the airfield. Thomson always reserved this choice location which gave their guests the best view of activities every afternoon. I joined Milt for some teaming talks with their management during one afternoon. Later, they asked if their engineering managers could exchange visits to our radars and Milt said sure, Lou will do that. Then we walked into their huge hospitality room and to the windows to watch the show. Slightly to our left we saw our radar antenna turning. Our marketing had arranged to have our Westinghouse logo, the circle bar W painted in white on its face. It was 12 feet in diameter and swept by every visitor's face every 12 seconds. Later four of their engineering managers and I went through their tactical radar shelters. Their transmitter drivers and final power amplifier were housed in one shelter. It was a tube type system and quite old. They rarely had the opportunity to upgrade their design. A second shelter contained their receivers, signal processors and their IFF interrogator and the third contained displays, maintenance equipment and spares. When I took them inside our shelter they were impressed with the compactness of everything and asked to see the transmitter. I opened the access door and showed them our solid-state modulator and pulled one of the modules - that impressed them most of all. We never competed with them again for the rest of my career. In September I visited The Hague and Madrid with McD's NAAWS Management.

Solid-State Projects, Stealth

In February of '88 Wally Hoff took over as GM of the Development and Engineering Division, Russ Bahner took over as GM of SRD. Herb Nunnally took over as GM of the Communications Division and I added the System's Engineering Department to my list of responsibilities. Within the next two years we recorded a number of significant wins. After losing the competition for the NEXRAD Doppler weather radar, our ATC department sold our transmitter which was almost a copy of our ASR-9 transmitter to the winner. Next, our early solid-state RF module developments continued to pay off when SRD booked the solid-state transmitter replacement for the Navy's SPS-40 radar. This followed our earlier contracts for solid-state upgrades for the SPS-37/43 radars. But the largest package of power we ever sold was for the Beam Experiments Aboard a Rocket, or BEAR Program. This was an SDI program which provided sufficient UHF power for a neutral particle beam ionization experiment. As implied by its name, the system was launched aboard a rocket and the experiment was successful. Milt continued to fund solid-state development at the device level where, working with Gene Strull and

our research labs, we started the development of a broad band RF silicon transistor and high power silicon carbide devices. Al Morse was our design interface for these activities and Derrick Page was both our device and applications expert.

Also early that year I got a call from our AWACS program office. They said that a Lt. Colonel at one of their meetings would like to visit me after lunch. He was dropped off and introduced himself then told me that he was one of the lieutenants in the audience when Gary Evans and I visited RADC ten years before. He said he would like an update of our design capabilities. I called Gary and asked him to join us and Gary gave him a quick overview on the white board in my office. Then I took him to see some of the antennas we were building. I asked him if he would like to visit the test range and he said yes. So I drove him there and one of the test people showed him around. I asked him where he had to go next and he wanted to go back to my office. He told me that he was going to make arrangements for a meeting to be held in one of our secure rooms at a facility we had out back. I could bring one systems engineer and one contracts person, both with TS clearances to the meeting. Within a week we booked the first in a series of black programs related to the buzz word of the time, stealth. I didn't see him again for over a year. We were in different groups in our executive dining room and he broke off and tapped me on the arm. He just said hello and said call me the next time you're up north, which I did. His group was responsible for the award of similar contracts some of which we booked.

Lincoln Labs, ARSR-4

We soon were awarded contracts for the antenna and transmitter modules for an experimental radar being developed by MIT Lincoln Labs for the Navy. It was ultimately known as the Radar Surveillance Technology Experimental Radar, RSTER. We developed an ultra-low side-lobe antenna which contained 14 channels of antenna elements. The received data was digitized and processed to achieve adaptive beam-forming, then all of the known processing functions followed. In short, this was part of the most advanced radar we had ever worked on in the surveillance radar division. We tried repeatedly to have Lincoln let us design a piece of the processor but they retained that in-house. Our antenna group did their usual great job on this design and Mike Fitelson managed the program. Lincoln Labs did their usual excellent job in developing an exceptional radar. Some years later its highly successful performance was described in the Lincoln Laboratory Journal. The article includes a picture of our antenna and a figure showing the 55 dB below isotropic performance achieved by our ultra low side-lobe antenna.

In mid-year the RFP for the ARSR-4 Radar was issued. This radar was the sensor for joint use by the FAA and the US Air Force. Accordingly, each organization had added its unique needs to the specification. The USAF specified a look down beam for cruise missile detection and the FAA specified circular polarization to enhance performance in weather. Our competition was GE and the Raytheon/Marconi team. We knew that we had to be compliant and that neither of our competitors could comply with their planar array antenna approaches without changing the laws of physics. So our resident genius, Coleman Miller, designed an antenna whose curved reflector was fed by a curved multiple beam array. In deference to reflector critics, we named it an array fed aperture. We used multiple beams on both transmit and receive and programmable Doppler processors. But as good as we thought we were, we had to respond to Milt's mantra. We had to be the low bidder. Milt asked me to develop target costs for production. I got help from Bob Fowler who was engineering manager of the Mode-S, and along with team members from purchasing and manufacturing we put that picture together. I managed the technical proposal and Guntis managed the separate system's engineering volume required by the spec. This was the only time we ever saw that volume separately specified. We supposed that since it contained all performance analyses proving that the radar would perform as specified in the presence of ground, sea and weather clutter along with jamming and in the presence of migrant birds that the FAA was going to use it to settle any issues with the Air Force. Guntis coordinated all of the inputs from system's engineering. The FAA later told us that it was the finest proposal volume they had ever seen. I reviewed it and did not change a thing. We had to be low bidder to win this job and we were. At the award price of over 400 million dollars, it was the highest single-value contract we received while I was Milt's engineering manager. Milt assigned Ken Lee program manager of the ARSR-4 and I assigned Bob Fowler as engineering manager. That win was soon followed by the award of the AWACS RSIP program. Bill Gretsch was already in place as EM of AWACS programs. Milt assigned Hank Airth as RSIP program manager.

Hochheiser:

By this time was most of your effort devoted to US customers?

Meren:

Most of my time was always devoted to US customers. My overseas travels fit into my work here which always took priority.

Systems Engineering Department, Export Regulations

When I took over the Systems Engineering Department its managers now reported to me. The sections within the department contained system architects, analysts, and software engineers which were usually assigned to programs within the command and control divisions. Also, I was now responsible for allocating IR&D funds to design and systems engineering in support of CCD's three divisions. I had a very capable manager, Rene Rosenthal, who I was able to promote to act as my deputy in the management of IR&D and administrative tasks associated with the 350 people in systems engineering while I managed the technical aspects of the overall engineering organization. Dr. Joe Conroy was managing most of systems engineering and we set up reviews of all of their study programs and other work not covered elsewhere. We treated IR&D tasks, both in systems engineering and in equipment design engineering as programs. Rene had the unenviable task of preparing the recovery brochure for all of our IR&D tasks to the satisfaction of Dr. Pan and we never failed to score highly in the recovery process. We also reviewed tasks that were funded by Milt's margin when we had a convincing need. He provided most of the funds we needed for broadband RF and silicon carbide device development until we could attain other coverage. Whenever I allocated profit dollars I would pass on a message that I got from Maurice Ani years before when Jackson reported to him. Having been a GM in the East building he knew about all of the political stuff.

One day at lunch he encouraged me to campaign for more IR&D, B&P funds controlled by Dr. Pan and also larger overhead budgets. Obviously he knew that Jackson was funding a lot of development. In fact, he encouraged Art Monheit to do the same thing when he managed the Navy and communications businesses. He said, "remember Lou, costs are recoverable, profit is not." So it was hard for me to spend profit dollars. Most engineers don't know or care where money comes from. And many - having never led a proposal or dealt with the market place - don't know how difficult it is to win most contracts. But every engineer I supervised or later managed knew when he was spending profit dollars. During '88, System's Engineering won 18 of the 20 study and development programs they bid. Additionally, the department's work force was spread over nearly 80 funded projects, programs and proposals. A snapshot of the work load during that period for the software budget center would show that the larger software engineering needs were those of the ARSR-4, 16; AWACS, 24; Mexico, six: Peace Shield, eight; and Special Programs, 16. The other three budget centers showed varying workloads, some as low as one in the case of a six-month study using two people. My new organization was rounded out by the addition of Dick Koehler. Dick had managed the TPS-43 and TPS-70 programs' organizations from the proposal through sell-off of nearly 200 radars. Milt assigned Bert Drummond and others to assume Dick's previous responsibilities in the programs organization. And that is pretty much how we finished the decade of the eighties.

During late ‘87 I was requested to represent Westinghouse on the team that would rewrite the technical portion of the export regulations. At the initial meeting in an office complex near DC I was assigned the radar category. I had Guntis help me and we both attended the subsequent meetings. The additional categories covering computers and communications were assigned to us. In establishing limits we selected 35 dB as the exportable side-lobe level. During this assignment we had access to a great deal of information covering performance of most foreign and domestic radars. Other information was made available to us but nothing written or recorded could be removed from the facility, including copies of our own work. During 1988 and 1989 the engineering managers and I set up weekly reviews of every program within the divisions they represented. Additionally, Milt scheduled reviews of programs within his divisions conducted by his program managers that I was scheduled to attend. Finally, I would conduct reviews of our other programs at either our facilities or at customer facilities which required that I travel in and around the Pentagon and also make required trips to Boston, New York and once to NORAD’s facility in Cheyenne Mountain in Colorado.

Hochheiser:

So now you have the engineering responsibility for FAA programs, surveillance radar programs, AWACS, air defense systems, and total responsibility for the special programs you mentioned.

Meren:

Yes, and also the Systems Engineering Department and our consultants, John Taylor, Coleman Miller and Omar Jacomini. But remember what I said earlier. I had an outstanding senior management team reporting to me and of course that’s the key to any manager’s success. I felt very comfortable when I travelled because of that.

Further Travels, Spain

And in ‘88 and ‘89 I had to have extension pages added to my passport. My travel log shows that in those two years I made 14 trips to Europe. I made two trips to Rome - one was with Wally Hoff, a DIVADS engineer and Len Scherer, a manufacturing estimator pursuing a teaming agreement with Alenia for a US requirement. The second was with Russ Bahner who took over as SRD manager when Wally took over as GM of the Development and Engineering Division and became my administrative manager. I attended the air shows in London in’88 and Paris in ‘89. McD had scheduled a number of NAAWS meetings with NATO in Mons, Belgium and The Hague as well as meetings

with the admirals and staffs of the Navies of member countries. On most trips we visited two or three countries and went to different naval and company facilities in those countries. In all, I visited Madrid, Munich, Bonn, Wilhelmshaven, Uberlingen, Brussels, and The Hague.

I also made a trip to Madrid to meet Bernie Harris and his Spanish Naval customer. While at the air show our London office was requested to set up a meeting for Milt and I with the Spanish radar company Ceselsa. They were developing a solid-state L-band radar for the Spanish Air Force and their customer suggested that they contact us. As I told you earlier, we had sold the TPS-43 to both the Spanish Air Force and the Spanish Army. At my first meeting they described their architecture and I told them that it looked like a close cousin of the Marconi Martello radar. They said yes, they knew. They had talked to GE and Marconi and both companies wanted to supply their own radars. But the Spanish government wanted to establish their company as a radar supplier for Spain and in the long term for South America. I said, are you aware that we just beat them both with our ARSR-4? They said yes, that's why we were asked to contact you. They showed me the hardware they had designed and their data processing approach and I told them that I would discuss it at home. I would call them within two days and I would visit them again if necessary on my next scheduled visit. When I got back I told Milt that I didn't think we could crack the government's position in wanting to develop an indigenous capability without a lot of whatever it took to change their minds. I said it was going to take them a long time to catch up to the Marconi radar, maybe over five years, and when they did they would suffer from its deficiencies. We agreed to offer them a co-development package for our W-2000 radar, but tell them that the reason we didn't propose it for the ARSR-4 was because it lacked polarization diversity and was more costly to produce than our winning approach. We could also offer them a co-production package such as that which we were contracted for in Egypt and pursue other markets as partners. I called them the next morning and told them my schedule. I also called our London office representatives who they knew very well. They did want to talk some more so I planned to include a re-visit on my next trip. On that trip, I met Bert Drummond who introduced me to his former customer, Air Force General M. who was now Chairman of the Joint Chiefs of Staff, Spain. He had earlier spent time at ESD, Hanscom as a NATO exchange officer. He knew a lot about Wx and was very friendly. He had suggested that Ceselsa contact us. He was also another of the finest and classiest gentlemen I've ever met. He took Bert and I to dinner at his private club. I told him what we had told Ceselsa. They were very interested but he didn't think that anything was going to get the government to change their minds. He asked me if I would consider conducting a one-day radar seminar for some radar engineers in the Spanish military. I told him I thought I could get permission and asked how many and he said most of them. As he suspected, Ceselsa was told to go it alone. We gave them a few tips but five

years later they still had not deployed the radar. Guntis and I were hosted at the seminar that was arranged about three months later. General M. had completed his tour as CJSF and was replaced by an Army general. The auditorium was nearly filled with Army and Air Force engineers.

Then in November '88 my wife and I vacationed in Brussels, Rome and Madrid. In April '89, we vacationed in The Hague, Salzburg, Venice, Vaduz and Zurich. We flew into Amsterdam and took the train to The Hague. At the train station a very nice gentleman helped my wife aboard as he picked her wallet out of her purse. He stole $1000 worth of traveler's checks for which I had the receipt. They were replaced within 30 minutes after we arrived at our hotel in The Hague. While there we stayed in a resort hotel at the beach near the home of the US Defense attaché to Holland, formerly the desk officer to Yugoslavia that I had travelled with. My wife and I both got lucky at the casino in the hotel one night and nearly paid for our vacation with our winnings. It really was a great trip. We drove down the Rhine stopping in Bonn long enough to take Jack Standish and his wife to lunch, then picked up our daughter Eileen in Munich and spent time in Salzburg and Venice and after she left, we visited Lichtenstein where I was able to add some stamps and coins to my collections which had been hard to find in the USA. My last trip in '89 was also a vacation trip. My wife and I spent the week before Christmas in Spain visiting Madrid, Valencia and Barcelona. Then we flew to Salzburg and met our daughters Eileen and Kerry and Kerry's husband, our son-in-law Paul Freedman. We spent Christmas week in Salzburg. Our friend Fred Popodi who had retired to Salzburg after his Wx career skied with the three of them in the Austrian Alps while Nan and I waited in a comfortable chalet.

Business Unit Reorganization, Israel

In February of 1990 I attended my final NFR-90 meeting, this time in Hamburg, Germany. The program was winding down, the Brits were moving toward their own design and some of the other team members were focusing on the NAAWS program. In March of 1990, the business unit re-organized. Seven non-DOD related divisions were grouped as Ed Silcott's Commercial Systems Divisions. In my reporting chain Kelly Overman replaced Wally Hoff as my manager. Milt was now GM of the Command, Control, Communications and Intelligence Divisions which included the communications, electronic warfare and space divisions and the AEW Department. My only trip in 1990 was to Madrid with McD to wrap up the NAAWS contract. Kelly now managed all of the systems engineers in the business unit and my reviews were now held in his office. I continued to attend engineering and program reviews for Milt's divisions.

Early in ’91, I was asked to attend a meeting in the Israeli embassy. As a result I was asked to visit Israel. Kelly had been planning a trip along with one of his marketing people so we went together. When we got to Tel Aviv we were accompanied by a representative of El Ul, the company that represented Wx in Israel. I had known him for years through our previous TPS-43 contracts and tethered aerostat payload work. He was also a major in the IAF when called to duty. Kelly had many things to brief at AF headquarters and with IAI because they had a large line of military products which they were selling in various parts of the world. My focus was on surveillance. During the recent war, which they were asked to stay out of, the building in which we were meeting was a Scud missile target. They knew that their TPS-43 radars could be modified to serve as the Patriot’s acquisition radar as did most of our TPS-43 customers. We were told on that trip that the Patriots caused more damage than the Scuds since they were using their tracking radar as an acquisition radar thus waiting too long to engage. Interceptions were made too close to the target instead of close to the launch point. I’ve described it that way because that was the reason that caused them to develop their own protection in the future. At one point the US suggested the Pave PAWS radar as a solution. The IAF asked us about our UHF solid-state capabilities. We had finished the BEAR program which by itself answered all of their questions and was a much more modern solution. They decided to develop an L-band active aperture array 3D surveillance and tracking radar for their Arrow missile which they were also developing. When we visited IAI their engineers showed us some early T/R module work they were doing and asked for my critique of their approach. I told them that we would approach the design in the same way and they said they knew that because they had read copies of all of the papers we had published. They had copies of brochures from every L-band radar supplier that I was familiar with except the Japanese. Later, Kelly described his systems and software organization’s capabilities as they applied to their requirements for the radar/missile interface which was one of his areas of expertise used in their F-16 radars. We offered to help them design the radar or any sub-system just as I had in a number of countries over the years.

On the evening of July 28th we were having dinner near the beach in Tel Aviv. We were with a couple of IAF officers and as I looked across the restaurant I saw an officer at another table handing a note to another officer and pointing at our table. He walked over to our table and handed the note to our rep. It was a message for me which had been routed through IAF headquarters announcing the birth of my first granddaughter. When I told our table they all lifted their glasses and as I looked across the room, so did the group at the other table. Later our rep told me that the IAF has a very short chain of command and only nine total stars on their generals and seven of them toasted her birth. Visiting Israel was a revelation to me. Since Kelly was a GM, our rep arranged for a VIP tour of Jerusalem. The owner of Israel’s leading tour company took us to Jerusalem

in a small size limo. Both on the way there and back he filled us in on the history of Israel from 1948, when he defected from Great Britain to Israel with a planeload of weapons and joined the fight, through his life there to that time. He stopped when some landmark or event or place was reached such as their Tank Museum. He took us on a walking tour of Jerusalem that went beyond any normal tourist tour. After getting a close view of what they had done in turning a wasteland into what they have, and all the while under the threats of people who want to kill them, I was amazed. When we got back I told Kelly and Milt that those guys were going to make it with their radar design. With all of the hardware we had there, added to our reputation as a top quality company, we had a lot going for us, except one thing. We didn't live there. If they wanted to do something, they would do it.

President of Westinghouse Airships, Incorporated

In July of '91 Bill Adams was promoted to GM and the AEW department became a division. He asked me to take over the airship business as President of Westinghouse Airships, Incorporated. Over the years I had been asked if I was interested in moving to another job and I said I wanted to stay. The first came from our Bay Bridge facility after the Deep Submergence Program. I was a supervisor and offered a section manager position. John Gitt had triggered it. Next came an offer from Tom Porter in our Programs Department. Then an offer of an assignment in Pittsburgh came through Dick Linder soon after he promoted me to manager of the Power Generation Section, all of which I declined. When my next offer from Pittsburgh came through Dick he said they're after you again. I told him I wasn't going anywhere and he said good, I think you're going to have a great career right here. Two other offers followed, one to manage a company Wx purchased in Ohio, and another to interview for a division GM position also in Ohio. When an opportunity occurred in one of Milt's divisions he said do you want the Division? I said only if you need me to do it. You know I don't like to get too far from engineering. But this time was different. When I asked him if he wanted me to manage the airship business he said oh no, this time you've got to make your own decision. In the last re-organization, Milt's surveillance radar business including ATC and the air defense systems were moved to Bill Jones.

Hochheiser:

Right and we've interviewed him.

Meren:

At about this time I had just finished taking my wife to several specialists to find the source of her severe weight loss problem. It was finally pinpointed as hyperthyroidism and treated by a doctor recommended by our doctor/nephew. It's now September and at lunch Bill Adams told me he was in a real bind. He didn't want anyone else to manage the program so I told him I would do it. The announcement that I was going to head the airship business was simultaneous with Jim Pitts' move to be GM of the AF Avionics Division. These moves eliminated a layer of management and the six departments that Jim and I had been managing now reported directly to Kelly.

Hochheiser:

What was Westinghouse Airships, Incorporated?

Meren:

In the late '80's, Wx had teamed with the British company Airship Industries and the team beat out Goodyear and won a contract to build a modern airship for the US Navy. Work had progressed to the point that a full-size mockup of the gondola had been built and a one-fifth scale airship which was 220-feet long was being built. Airship Industries had produced a number of commercial airships for companies like MetLife, Fuji and Budweiser. These were built to commercial standards. Sales had fallen off and the company was heading for a fall which would jeopardize the Navy program. Milt renegotiated the Navy fixed price contract to a CPFF development contract for over 375 million dollars. Less than 10 % was funded. Also, Wx bought the company which by mid-'91 resided in the AEW division along with the AWACS. Bill Adams was now managing the division. When Westinghouse bought Airships Industries it was renamed Westinghouse Airships, Incorporated and I took over as its president.

Hochheiser:

So did you move to the UK to do that?

Meren:

No.

Hochheiser:

You did that from right here in Baltimore.

Meren:

Yes. We shared a hanger in Elizabeth City, NC with T-Com. We had an organization of airship designers in Luton, in the UK, and we did our part of it right here in Baltimore. As I said earlier, the program was grossly underfunded. As we tried to get the Navy to provide additional funding for the full-scale airship - the Sentinel 5000 - we also tried to sell smaller airships like the Sentinel 1000 which we were building in NC. After about a month in my new job it was determined, after a stress test, that my wife would need open heart surgery. I was very concerned about her health but her rapid recovery and her attitude reduced my anxiety. In late November she said she wanted to test out her new self and we took a trip to Salzburg.

We had discovered the reasons for our funding problems. The underlying problem occurred because the airship was not specifically called out in the congressional budget. Our political liaison office was given that problem and Milt, Bill Adams and I took several trips to DC whenever we were asked to help. Additionally we hosted various groups of Congressmen, Senators and Navy Admirals at the hangar in Elizabeth City. After a briefing we would take them up for a ride and talk about the types of payloads we had funded or were proposing. But even after it was budgeted, the NAVAIR Admirals were concerned that all money spent on the airship would be deducted from their fixed-wing aircraft needs. When an experiment was conducted using an aerostat tethered to an AEGIS cruiser for its protection it nearly matched an airship approach we had proposed. However, our payloads during AEGIS experiments were limited to radio communications and passive detection. Now we had support from NAVAIR if we could get NAVSEA to foot the bill, but they had the same concerns that any money they allocated to the airship would come out of their hides. For a short period of time, DARPA was given responsibility for the program and was preparing for a role in what was simply known as the mountaintop experiment. Milt and I met with the head of the administration and another person. Much earlier that person had attended a meeting in one of our secure facilities, SCIFS. We were reviewing the performance we had achieved during testing of the full-size UHF antenna I described earlier. During that meeting I told him that we would give them that antenna and other hardware if they would sponsor an airship supplement to the mountaintop experiment. Although they gave us some support toward that task, it never matured into a program. Again, funding was sparse. The program which I mentioned earlier where we provided an ULSA to Lincoln Labs was being funded by SECNAV and they were very successful with the mountaintop tests. In the meantime, Jim Luck - who had transferred to the program - was visiting military facilities with emerging requirements. In one case he had followed an Army requirement which looked like a sole source award until the command it was handed off to decided to compete it and ultimately killed it. In the meantime Jud Brandreath visited every

prospect or potential prospect around the world. As directed by the Navy, their funds were used to develop a top down/flow down of requirements and we allocated most of those funds to Joe Conroy's system engineers.

We had one last shot at the mountaintop at a meeting arranged by Lou Folzer who was responsible for developing every operational naval scenario in which the airship could play a role. His timelines easily showed the need for an airborne platform to protect surface assets and were followed by hard data showing the cost effectiveness of the airship compared with all other platforms. His results were indisputable and no one disagreed. The subject of the meeting was the performance of the Airship in support of operations in regions such as the Arabian Gulf littoral. We used our UHF mountaintop radar as our straw man approach. Everyone agreed with our approach. When the Admiral asked for comments, the only comment came from APL's representative who asked me if we had run any system simulations at L-band and I said we had not. I've spent a lot of time talking about our funding problems but I don't want to overlook the great design that Roger Monk and his team turned out for us. I visited our facility in the UK just once and addressed all of the employees. I wound up my talk with the hope that we would soon win a contract from their MOD and soon after that Gordon Adams, who had been with the airship program since its inception, brought it in. On that trip I visited Ferranti in Wales who were designing the flight control computers. The system was based on the Motorola 68020 architecture and they went through a complete review of their software and schedule. All aerodynamic control surfaces of the airship were optically signaled through fiber optic data links making their subsystem part of the world's first fly-by-light flight control system. The airship was assembled, tested and flight certified at the Weeksville facility. Those activities were managed by Rudy D'Urbano.

Bangkok Gridlock, Chilean Air Show, Mexico

In February '92, Bill Adams and I visited Bangkok and met with the chief of their National Police Force. He wanted to hear our solution to the constant gridlock problem being experienced in Bangkok. Bill and I experienced it on the morning of the meeting when we took a cab from our hotel to his office 12 blocks away on the opposite side of the street. The first four blocks took 20 minutes and the next four took 15. We walked the next four in under ten very hot minutes. He was interested in our approach which included a large horizontal TV display augmented by a video generated street map. The operator could control street lights remotely and direct officers to where they were needed. We told him that we could tailor the payload a number of ways for night vision or as airship industries had done in Paris, provide police with a detailed video map of the city for pursuit needs. The next day we found out that he could not get approval to

use an airship because it would be capable of looking down at bases and facilities managed by the Army and the Army's commanding general would not permit it. It sounded to us like the two of them were from different countries. Our rep told us that they each commanded comparably sized organizations and were constantly in turf battles. Among the chief's five cars were a Bentley, Mercedes and Lincoln. Our rep took Bill and I to dinner but just after we ordered he got a phone call from the chief asking us to join him at another restaurant. He cancelled our order and drove us to a spectacular restaurant where we joined the chief and his guest. She was a beautiful young lady who Bill and I agreed would get our vote for Miss Thailand. Bill and I flew to Singapore where we met Milt and attended their air show.

In March I was asked to attend the Air show in Santiago, Chile. Our international marketing manager for South America was Harry Goldberg and before I left I asked him who he expected me to brief. He said I was the only one going so I should be ready to discuss the ASR-9 and Mode-S, the TPS-70 and tactical air defense, and the W-160 and SPS-58LR. He said he could find no interest in airships. My first briefing was scheduled for the following day at the headquarters of the AAF, the Chilean FAA. Our booth was close to the US FAA booth and I introduced myself to their regional manager. Harry told him of our scheduled briefing and he asked if he could come along. Our in-country representative who I had met in Baltimore took care of all hospitality arrangements, drove us everywhere we visited in Chile and took us to the meeting. The next day he drove us to naval headquarters in Valparaiso where I briefed our Navy radars. We had lunch with four Naval officers at a restaurant that was advertised as being in the Pacific Ocean. It was on a point of land that was beyond where seals were sunning themselves. We could see them behind us through the thick plate glass windows that surrounded us. The next day I briefed the Chief of Staff of the Air Force whose primary interest was the TPS-70 and its mobility. When I toured the show and gathered a few brochures I visited the largest exhibit at the show, that of Israel. I was surprised at the amount of different equipment they offered. The following month Kelly had been requested to provide some additional RF module information to Israel and asked me to go along with the two engineers being sent. One was Mike Fitelson and the other was my son-in-law Paul Freedman. After our meetings, our representative asked if we would like to visit Jerusalem. He made the same arrangements for us as on my previous visit and, remembering my previous visit, the owner of the tour company took us on a different tour stopping at different places on the way making it another enjoyable and informative visit.

In July I visited Mexico with our senior airship marketer where we met our in-country representatives, a man and wife team. He was a rocket scientist and she handled the business when he was at a launch. We briefed the air defense users on an airship with a

multi-sensor surveillance system, Radar, IR, TV and low-light level TV. Our reps said they would shop it around to other organizations potentially interested. During the next few months we were occasionally getting calls from them and I started putting together a modular proposal which described the system we were discussing. By this time we had prepared a specification for the airship and its estimated cost which is as far as I ever took a bid. At Wx, signature responsibility started at the GM. Often, customers and partners were deceived by titles such as president or director. In my case, Bill and Milt were in my chain. I had also been preparing a priced catalog of payloads which included several different radars, E/O sensors and eventually some lightweight weapons systems.

In July I visited the Canadian company which provided fuel cells for a fleet of buses hoping to provide an alternative power source for the future. I was interested in the power-to-weight ratio which they could achieve for an airship application but they were years away from meeting our needs. At the time we were carrying a 150 gallon bag of gasoline to fuel the two souped up Porsche engines we used to propel the airship. As an adjunct to our business we would maintain, repair and paint the fleet of smaller airships that had been sold by Airship Industries. One thing you could always count on seeing was a bucket partially full of bullets that had been removed from the envelope. It didn't bother me too much that one would hit the fuel bag because of designed safety precautions but each one reminded me of the idiot who fired it and the possibility of hitting the pilot or others aboard. Soon after that we funded a German company to look at a version of a lightweight diesel engine they had demonstrated at Oshkosh. It was seen by a Wx systems engineer, Hank Hiscox, who flew in for their annual air show and asked them to call us about it.

Hochheiser:

Sure.

Meren:

Then in late November. I got a call from our rep in Mexico. The Attorney General of Mexico wanted to talk to me personally. She told me that her husband was at a missile range and that she and I would meet with him. She said he spoke English. I met him on December 3rd after we walked through a gauntlet of heavily armed men in the hallway outside his office. We spent the first 20 minutes talking about me, my family and my hobbies. When I told him that I had been a collector of airship memorabilia for many years I found that he was a fan of airships. Then he opened a folder and asked me to talk about my experience with the sensors I mentioned in my resume and their use for drug interdiction. Our rep had submitted my resume and a data package to him prior to

our visit. The data package included a copy of our sentinel airship specification, airship pictures, and pictures of the sensors we had provided in and around Mexico, as well as those available as payloads. We had included a map showing the radar coverage presently in place with Wx radars and how it would be augmented with a fleet of six airships. Finally, it included an airship co-production plan that Jim Luck had put together while pursuing an opportunity in Mississippi.

I started with the TPS-70 which they had deployed to monitor their Guatemalan border and then the TPS-63s aboard the LASS aerostats along our common border. I added coverage which would be provided by the ARSR-4, particularly from its look down beam. Then he wanted to talk about the airship we were proposing and its payload. I told him that our primary surveillance sensor was the Lass TPS-63 and that our secondary radar would be a solid state IFF feeding through its antenna. Radar data would be displayed at two consoles identical to those used in their TPS-70 tactical air defense air ops shelter. These were the programmable AN/UYQ-27 displays. Next I described an E/O pallet that included TV and low-light level TV cameras, an IR subsystem and a third console housing a TV type display. Then I described a communications pallet which included air-to-air and air to-ground voice and data links. Finally, I described an ESM pallet which would be provided by our Brit facility using mostly Israeli equipment. He asked me for an estimated cost and I gave him a range between 12 and 15 million each depending on selected payloads. Then he asked me about the costs of co-producing the airship and I told him that our estimate for the Mississippi plan was 10 million but we felt that based on discussions with Ron Rattel, one of our GM's involved with Mexican co-production, it would be lower. He thanked me for the thorough job we had done in providing the information he needed. He said the US had offered Mexico a fleet of used helicopters for use in drug interdiction along with Army support and training until they could take over and his question was always who is going to direct them to the place to interdict. We don't have an AWACS. He added that either the US or Mexico would tire of that arrangement and end it. The meeting took nearly an hour. He thanked me for coming and said he would contact our rep within the next day or so. We left and after lunch I flew back home. As I was writing my report on my way back home I thought that I had just met with one of the sharpest individuals I had ever met. I had dealt with many high level military officers and civilians but rarely one-on-one. Nearly everyone had a staff. But this general was well prepared. He didn't want a sales pitch - he wanted facts which he could use to sell the program to his boss who was President Salinas of Mexico.

Two days later on December 5th our rep called me and said he would be ready to see me on the afternoon of the 9th. We had a fifteen minute meeting at which he told me what had been selected as the mission payloads and asked me for a quote. I told him he would have it within the hour. I already knew the answer but I told our rep that I would

call her after I called Baltimore. I called Bill Adams who was unavailable, so I called Milt and asked if he wanted me to commit him to an 84 million dollar program. He agreed and that was the price she gave him. He told her that he should be ready to sign off after the holidays around mid-January. Later that evening she took me to dinner. She had kept her husband informed and he in fact helped make some of the final payload selections. When I got back I added some vacation days to our plant shutdown. I left on December 11th and returned on January 4th. Two days later at breakfast I was flipping through the paper and skimming the headlines to see if there was anything I wanted to read. I got to page 23 and stopped. I read the caption under two side-by-side pictures which said President Salinas, left, who sees Clinton in Texas Friday, has replaced attorney general Ignacio Morales Lechuga, right. The headline read: "Mexico Signals Clinton before Meeting" and its sub: Salinas's Cabinet Shifts Anticipate US Debate on Free Trade Pact. So I did read that article and I have a copy here in my briefcase. Among other things the article said that his replacement obviously was intended for the international audience, to send a message that Mexico is trying to take a stronger stance on human rights and drugs. I got to work around 7:15 and before 8 I got a call from our reps in Mexico. They were both on the line, she on the verge of tears. She told me how badly she felt, then said she would talk to me again soon. He told me that the AG was going to be appointed Mexican ambassador to Spain. He knew that the new AG was a former head of the government's human rights commission and never involved in drug prosecutions. He also felt that Mexico was going to accept the offer of helicopters. I watched for signs of success in their acceptance of the helicopters but the reverse happened. Within three years Mexico told the US to take them back. So the only casualty of those international political moves was us. It normally takes programs longer to go through their procurement cycle. But this pursuit turned into just another terrible way to lose and one of the biggest disappointments of my career in just 31 days.

Hochheiser:

So the whole Mexico airship program was abolished.

Meren:

Yes.

Chief Engineer of CCCI&M Divisions, Taiwan, Symposium, Raytheon

Then in February of '93 Milt was named corporate VP, CCCI&M Divisions. I continued my airship assignment and shortly our airship was certified and we booked the UK MOD job which Gordon Adams had followed for a long time. In recognition of the efforts of

Gordon's team I gave him a solid gold replica of the airship pin our marketing people gave away at shows. I told the group that he was the custodian of it and could rotate it around or pass it on to the winner of the next airship contract. I had taken a Krugerrand and a pin to a jeweler who sometimes made gifts for my wife and had him melt the K and cast the pin in gold. In June, Rudy D who had managed our airship through certification took over as president and I transferred my people to him and went back to my office in the West building and was named Chief Engineer of Milt's C Cubed I&M Divisions.

Hochheiser:

Right.

Meren:

When I came back I continued to manage a couple of special programs. Earlier I had been brought close to some of Bill Montgomery's space programs but that was put on hold when Bill died. Now, Bob Iorizzo picked up that task which was completed in late '93. My traveling was mainly to establish a relationship with a company in Taiwan. We had provided a lot of hardware to Taiwan and I had personally briefed nearly every agency in Taiwan at one time or another. We had sold our Hawk DSPs to their Army, our W-160 radars to their Navy and our TPS-43s to their Air Force. Also their Air Force finally got US approval to buy 150 F-16s. But when we started developing our plans for the engineering and support center the product that was going to trigger the startup was Milt's EW Division's ALQ-131 pod. This was the most recent bid from one of Milt's divisions and it was currently under evaluation by the Taiwan Air Force. We had a lot of electronic equipment in Taiwan, and so did the company we were working with, MITAC. They were one company in a group which included a shipping company, a company that built pleasure boats, a food business and a recording company among others. I interfaced with the GM of MITAC and Milt interfaced with the chairman of the conglomerate. They had provided thousands of computers worldwide and we were planning a commercial support capability in addition to the support of their military sales. They had bid a large lot of computers to Canadian Westinghouse and were waiting for an announcement. They asked me to look into it for them and I told them that I would try to find out when they could expect a decision. When I contacted the GM I told him that we were trying to build a relationship with MITAC and he said they just selected them as the winner. He asked me if I wanted to tell them and I said no. Nevertheless, they tried to credit me with helping them until I finally convinced them that they did it themselves. I was surprised to learn that they were outsourcing some of their work to mainland China to keep themselves competitive.

Soon after we started working together, MITAC supported the two systems engineers they sent to participate in the test of some of the hardware we were building for Taiwan. We located them in an office directly behind the guards at our entrance. They lived in an apartment nearby and soon fit into our work routines. Along with our MITAC alliance, I had been working with Sanyo and through them a Korean device manufacturer. Together, we investigated the application of our solid-state module technology to Sanyo's product line then to other products. We started with a microwave oven and eventually looked at higher power applications such as those used in making plywood. We looked at requirements for plastic reclamation and tire decomposition and other products and processes which used RF energy. We would not be competitive with any product which used a magnetron until a high power monolithic device was available and that is what I was pursuing with Gene Strull and our research center.

During that time, Joe Yang who had replaced Dr. Pan as chief scientist asked me to conduct an R&D symposium in Taiwan. It was to be an unclassified version of the annual R&D symposium Wx conducted, mainly for its high level DOD customers. John Gitt and I had been critiquing the presentations for the past few years. I got Garth Mackenzie's help and lined up the speakers. Joe, who also managed international defense marketing, issued the invitations. We used artwork and posters developed for the Baltimore R&D symposium. Milt and Joe attended and were pleased with the results. Over the years I learned that it was difficult to measure the results of our participation at air shows or the value of presentations such as at our symposium, various seminars or conventions. But I don't know if anyone ever kept book on it. On one of my trips I stopped by our office on my way to the airport and one of the managers asked me if I was aware of what was going on with the ALQ-131 bid. I said no, I seldom get involved with bids for existing hardware. He said he was getting strong vibrations from people he knew that the job was in serious trouble and that Wx was not going to win. I said are you kidding me, we've built over a thousand of those pods.

Hochheiser:

Right.

Meren:

I talked to our man on the scene and I said, are you hearing anything about how we're going to be wiped out on this bid? He said yes, but I'm not paying any attention to it or words to that effect. That, yes, he knew our price was higher than our competition who

was Raytheon. When I got back I said to Milt, here's what I'm hearing. He was alarmed and he got in touch with the billionaire conglomerate chairman and got him to delay the award. But it was too late. Raytheon came in and ate our lunch on a product that we had been producing for years. It not only disturbed me because it seriously impacted our plans, but because it was Raytheon again. It was not the first time it happened and is probably still going on. Raytheon is a tough competitor.

Hochheiser:

Right.

Retirement, Legacy

Meren:

I know this interview was about my career and I've mentioned a lot of names, but the point is that without them and many more, I wouldn't have had a career. In early '94 I started planning for an early retirement. My wife's health was deteriorating and we wanted to get started on our long term objective to purchase our retirement homes. In our travels around the world we had selected locations and gathered information. Our preliminary list included homes in either Tiburon or Del Mar, California; Salzburg, Sardinia or Corsica; and Chile or Argentina. We planned to keep our home in Bowie, sell the three town houses we owned and implement our plan. It was difficult for me to leave what I had long felt was the best job in Wx. I was at the peak of my earnings and didn't want to leave but in early '94, we decided it was time. On my last trip I visited Taiwan, and Seoul. I was accompanied by Garth who was going to take over with both MITAC and Sanyo. In Taiwan, MITAC honored me with a farewell banquet and in Seoul, Sanyo had a similar send off in one of the small buildings of an ancient park. My Wx retirement party was held right here in the museum.

I think I can best summarize my career by looking at a map of the USA and pinpointing the location of all of the radars I've had a hand in fielding. I would see the ARSR-4 at 40 sites encircling the country and the ASR-9 at 137 of its airports. Inside the USA, I would see the ARSR-3 at 23 sites. The Mode-S would be seen supporting all three radar types at all of those sites. Then across the Southwestern border I would see our TPS-63 radars in tethered aerostats. Across the country I would see a mix of over 100 USAF AN/TPS-75s and USMC AN/TPS-63 tactical radars. I could then take a God's eye view of the Earth and see our radars on nearly every continent, on many ships and on several fleets of AWACS. Finally, I would see the radars we helped develop for the SEASAT and space shuttle. Collectively, our radars have provided surveillance of most of the earth. The

shuttle radar has provided a radar view of it all. Our Deep Submergence System gave us a view of inner space and mapped the bottom of some oceans. In my career I designed or managed the design of hardware that went on every platform except for a fighter aircraft, but no one in the world was better at that than our Avionics Division. Also during my career I made 59 international trips, visited 41 countries, and flew around the world seven times in pursuit of international business for Westinghouse. But in the final analysis I knew that all of those things were as fleeting as fame. I remember reading specs that included a 30 year life requirement that I've outlived.

When I worked for the power company I engineered hundreds of jobs for them and when I left the superintendent told me that I had left a great legacy. So when I retired I thought about what he said while looking at my body of work for Wx. I disagreed that all those things made up my legacy. None of them qualified. My legacy is my family. Although a lot of people patted me on the back and said that's a great design or that's a great display or what a great radar, many more people have complimented me on my family using descriptives like great, marvelous and awesome. Before my wife died, just two months ago, the word that best described her was remarkable. Along the way, my identity changed. My daughters and both sons-in-law used to be introduced as this is Lou Meren's daughter or this is Lou Meren's son-in-law. Now I'm introduced as this is Kerry Meren or Eileen Bittner's dad and this is Paul Freedman or Kevin Bittner's father-in-law. Three are Northrop Grumman management employees and they along with our daughter Kerry - who works in the Pediatric Oncology Center at Hopkins - and our grandchildren are subjects of enormous pride to me and to our extended family. And since this will be an historical document I'd like to record the names of my grandchildren, Gillian and Emmett Freedman, and Patrick and Shannon Bittner.

Westinghouse granted me a tremendous engineering career opportunity. I shared that great career with outstanding teams of people. I always had a lot to do and worked on a lot of different things. I was always well paid and never asked for an assignment, transfer or raise. Whenever I looked at the people supporting me I liked what I saw. The same can be said about looking up until very late in my career. As early as 1973 both Jackson and Tom Tomlinson told me that Dick Linder would manage the Defense Center someday. In 1986, he replaced Harry Smith upon his retirement. I know that some people kept a list of succession. I wrote mine down when Bob Kirby was CEO. I had picked Jim Beggs to succeed him. That didn't happen. A few years later I picked Tom Murrin and that didn't happen either, but I picked him again and added Linder to follow him and Milt to follow Linder. None of that happened but I think my picks would have been better than who we got. And as a wise man would say, who can dispute what you're thinking. When Milt read my going away letter from Dick Linder and got to the

part that said I probably worked on more programs than anyone else he ad-libbed, ‘couldn’t hold down a job,’ huh.

Hochheiser:

Well you certainly [Chuckling] covered an awful lot of programs in the last two hours.

Meren:

Yes, and it was really an exciting opportunity.

IEEE, Papers, Patents

Hochheiser:

One other thing, since you know I'm from the IEEE. Were you ever a member or otherwise involved with IEEE?

Meren:

Yes, I was when I was in college. It was the IRE and later the IEEE. Then Bill Jones and I wrote a paper about surveillance radars. Actually, we were very busy at the time so I provided a lot of information and photographs but Bill did most of the work.

Hochheiser:

[Chuckling]

Meren:

I retained my membership for about four years. Each month when the Proceedings were published I would pick out an article that I would read and understand. I did that for about three years and had those issues bound. Finally I got an issue that looked like it would take me an inordinate amount of time to understand so I set it aside and let my membership expire. In my home library I have three bound volumes of the IEEE Proceedings. Up through probably 1960, maybe '61. I rarely got a chance to read any more articles. I ghosted an article for an FAA program manager to present and presented it myself when his boss balked. I also wrote a paper with Bernie Cataldo that Merrill Skolnik asked for. It covered our scan converter designs.

Hochheiser:

Okay.

Meren:

The first paper that I wrote for Westinghouse got kicked back by our radar manager at the time, Colin McCadie. He said this is a great paper but it's too detailed. If you gave this to a customer or to our competition, they could design this display. The subject display was the one I mentioned earlier as the toughest job that I ever had, the display for the Splash Detection Radar. When I started stripping it down I decided there was not enough left to publish. Within my first five years at Westinghouse, I wrote nine patent disclosures. Five of them were rewarded with a check. Three applied for patents. All three were classified secret. I don't know what ever happened to them. But if they were patented I would have known about it. Over the course of the rest of my career, I added 18 more disclosures but I never got a patent for anything. I still have a portfolio of ideas that I have reviewed with my family. If I don't get around to them, maybe they will. Three of them have come to fruition, unfortunately byothers.

Hochheiser:

Ah.

Meren:

We used to have patent drives and I sometimes suggested patent subjects to be disclosed and some things were patented like the Crowbar in oil that I mentioned when I talked about the ALCOR

Hochheiser:

I think we've covered everything and I think our time is up.

Meren:

Okay.

Hochheiser:

So I would like to thank you for coming in to do this.

Meren:

You’re welcome.

Hochheiser:

And it’s been a pleasure to listen to you talk about your career.