My name is Lee Kinard and I worked with E-Systems in one name or another from April 1968 to April 1978. Working with ESY was rewarding and enjoyable. I grew up in Austin, Houston and Temple and graduated from the University of Texas engineering school in 1966 with a BSEE. My first job was with Collins Radio on Arapaho Road in Richardson, TX.

After a little less than 2 years at Collins I was feeling pigeon-holed because we continued to redevelop the avionics control boards and it wasn't a challenge anymore so I began to look around. I think I saw an ad in the newspaper for LTV Electrosystems in Garland for engineering help and I decided to send my resume to them. I had no idea what they did. They responded positively and invited me for an interview. At that time I was making about $160 per week with Collins and I decided that if I changed jobs, I needed about $200 per week. That's a 25% raise. I interviewed with Bruce Abernethy who was the Manager of Display Systems and we hit it off immediately. I think Bruce was impressed by my digital design background and he wanted me to come to work for him. I told him what I was looking for and he seemed unfazed. However, the offer had to come through Personnel Relations and they had some say about salaries. As I remember, I was asked to come to another interview with them to talk about salary. I remember some argument with them, but I stuck to my guns and got the $200/week offer and took it. I gave Collins the obligatory 2 week notice and walked into a new job in April 1968.

LTV was a different kind of company. Jimmy Ling was running LTV and buying companies right and left and no one knew where he was getting the money to buy other companies and how he was doing it. He was in all the newspapers and business magazines including Time and Newsweek. Apparently, he started the Ling Company and then bought TEMCO and Chance Vought to make the company Ling-TEMCO-Vought or LTV. The company I went to work for was LTV Electrosystems to differentiate it from the rest of the company and define it in electronics. It turns out that the facility was originally the TEMCO or Texas Engineering and Manufacturing Company facility that was started by a guy named Bob McCulloch. I never knew him, but I heard glowing things about how he made his company function. Apparently, in the hard times of the '50s, McCulloch solicited various types of manufacturing to keep his company afloat and was successful. I heard that they manufactured washing machines, dryers and go-carts, but I have no evidence to prove it. See the links:

https://en.wikipedia.org/wiki/Temco_Aircraft

https://en.wikipedia.org/wiki/Ling-Temco-Vought

At that time, LTV Electrosystems owned a full section of land (640 acres, 1 mile x 1 mile) in Garland fronting on Jupiter Road and bounded on the east by Shiloh Rd. between Forest Lane and West Miller Rd. I remember the address as 1200 South Jupiter Rd.

When my wife became pregnant with my youngest daughter about October 1969, we decided to move from our little apartment on West Walnut into a house and began to look. We had saved a little money now that I had a good raise, but it was still tight. We found a 4 bedroom 2 bath home for $26,000 at 3914 Hillsdale Ln. in Garland and we bought it. I was then about 2.5 miles from work. We lived there for 4 years and enjoyed living in a house, on a cul-de-sac and near a large park.

Display Systems Dept. of LTV Electrosystems
Display Systems was a different workplace from Collins Radio and a big change for me. The whole company was small and this department was quite small. It consisted of
Bob Miller, Director
Bruce Abernethy, Manager
Dave Lubin, engineer
Wes Crenshaw, programmer
Me, engineer
Dave Hall, coordinator
Frank Sherry, Sales
Johnny Johnson, technician

Bob had developed a scribing type of projector while he was in California called the Iconorama and then improved it. Somewhere along the way, LTV management decided to buy his company and bring it and him to Garland. This job lasted for about 2-3 years and involved a lot of travel in the US and abroad. We had a demonstration system that we would box up and put into two Ford station wagons for transport. So we would fly to wherever, carrying the 2000 lbs. of equipment as excess baggage and pre-rent the wagons so we could drive to the location. We called it our dog and pony show. One memorable trip was to Ft. Bragg in South Carolina to demo to the Air Force and Army who were doing joint field exercises for a week among the pine trees. We took all of our equipment and were required to live like the Army in tents and eat Army chow for the week. We also were required to wear Army uniforms, helmets and gas masks. We set up our equipment in what is called a DASC and commenced to play the war games with the military. Our three projectors showed the situation display. One projector showed a static background map (blue) of the entire area and another plotted the FEBA and the enemy (red) and the third plotted the friendly (green) forces on a 20x20 ft. rear projection screen. The FEBA as it is known, is an acronym for Forward Edge of Battle Area and is the line of division between friendly and enemy forces. We had joined up with a department of Honeywell Computers in Florida and they provided a system called TACREAC which consisted of the same type of computer they provided for our display system and some other equipment that the pilot had in his jet aircraft. He had a reticle on his helmet so that he could spot forces on the ground and then push function buttons on his dash for enemy or friendly, quantity and type of forces, etc. The location, type, quantity and other info was processed by the on-board Honeywell computer and radioed to ground and then to our Honeywell computer to process the info into plotting commands on the projectors. So as long as the aircraft was flying and sending data, we displayed near real-time information for the commanding officers on the situation display. This is similar to a CIC room on naval vessels, but it was automated and very impressive at that time.

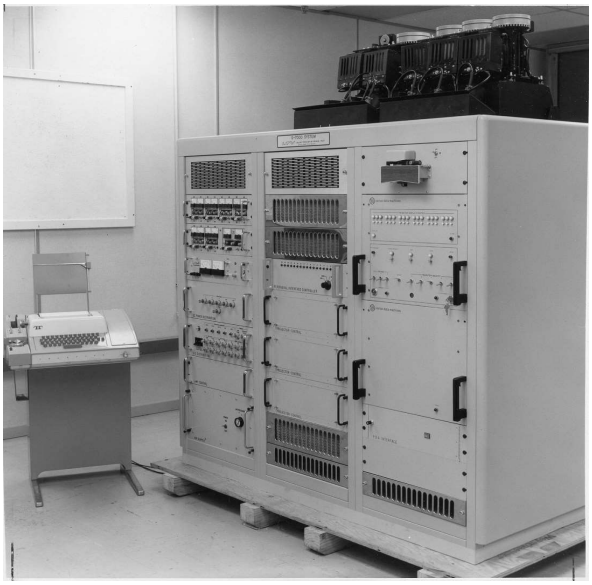
The department had quite a bit of room for offices and a lab. I had my pick of where I wanted to office so I picked one convenient to everything. Bruce was interested in all kinds of display equipment, and computers were becoming smaller and ubiquitous. There were many brands of computers at the time and they were termed mini-computers as opposed to the giants of IBM, Sperry Rand and Control Data. I remember the Lockheed SUE, Varian 620i, SEL, Data General, DEC, Computer Automation and many others. We settled on the Varian 620i and bought one to work with in the lab. I went to school in Irvine, CA for two weeks on the

computer and learned how it worked. That was my first introduction to the internals of a computer and how it functions, down to the gate and core bit. The instructor was really good and had taught the course many times and was retired military. Bruce also located a company named Imlac which manufactured a computer and display combination and he couldn't wait until we bought one. The programs were loaded with paper tape using ASCII code and there was a space game that came with the machine which contained the Sun and two spaceships each of which had a neutron cannon on the nose. The Sun exerted gravitational pull on each spaceship depending on how close to the Sun it was and it also affected the cannon's fireball. Two operators used opposite ends of the same keyboard to fire either the rocket or the cannon and change direction. The object was to shoot the other spaceship and blow it up. You could use the force of the Sun to bend the fireball trajectory and shoot the guy on the other side of the Sun. We played with that thing for hours. In fact, the first time we had the space game working, Ted Gage and I played with it for several hours in the afternoon, lost track of time, and wound up leaving work about 7 pm. When I got home, I explained to my wife why I was so late and she couldn't buy it. She could not understand grown men playing a stupid game and forgetting about the time. I think she thought I was out carousing and she was mad at me. But I was always in trouble for something.

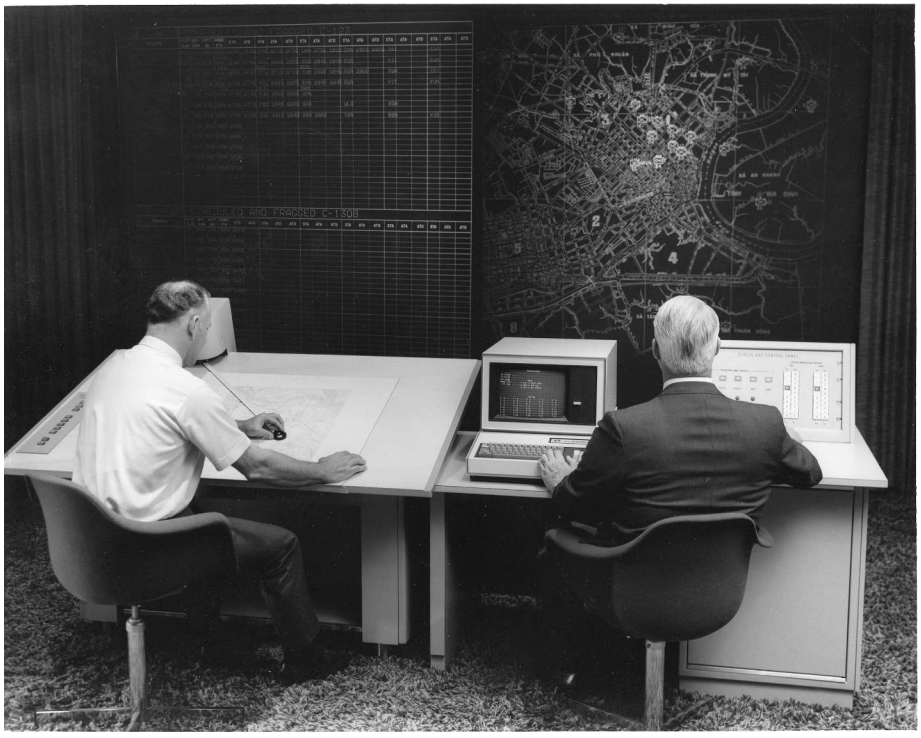
We used the Varian machine to control the projectors similar to the way the Honeywell computer did, but the Varian was much less expensive and much easier to repair. The Honeywell machine was mil-spec-ed and very expensive, but it could work underwater on a battleship. The Varian could not. We did use the ruggedized version of the Varian on two display systems (G-7000) we sold to an undisclosed customer. The ruggedized version was mounted on shocks and had restraints for the plug-in boards and was in an aluminum chassis instead of plastic. It had two rows of boards which included two 4K word (1 word = 16 bits) core memory stacks and an additional chassis could be cabled to it to hold another 16K of memory.

About this time, RCA introduced a keyboard and display unit called a VDT or Video Data Terminal and the company bought one for our department. This was the first of the dumb terminals which provided the man-machine interface required by computers. RCA invented it and patented it and charged a royalty on every one ever produced by anybody. Up until that time, people interfaced with computers through punched cards, paper tape and print-outs. The small (at that time) IBM 1604 utilized a modified Selectric typewriter mounted on the console and commands could be typed in and output was typed out by the machine. But the VDT contained a separate keyboard connected to the unit with a cable and the main unit had a CRT in it which displayed characters in rows. The characters were generated in a charactron tube (character mask inside a crt tube) and displayed in the proper location on the screen. The keyboard, as it was engineered by RCA, seems to have been a modification of the teletype keyboard, since it contained a small motor driving cams engaged by the keys. The VDT had an RS-232C interface connector on the rear apron so that it could be connected to another device such as a computer. At that time, there were no standard RS-232C interface boards so I got the job of interfacing the VDT to the Varian computer. There was a company named Control Logic who manufactured a varied set of plug-in logic boards, wirewrap backplanes and chassis just for interfacing digital elements together. These boards were about 3x5 inches with blue PC boards and had AND/NAND and OR/NOR gates, shift registers, etc. in modular form. So I set about designing an interface between the Varian 620i

and the RCA VDT using these logic elements. After development of the schematic, I was able to generate a list of materials and a wire list for the technician to wire wrap the backplane. We called the interface box a Peripheral Interface Controller, or PIC. It was a general term so that we could include interfaces to other pieces of equipment as well. It mounted in a standard 19 inch rack and the faceplate was 5.25 inches high.



G-7000 Rear Projection System



About this time Bruce decided that we needed a new set of digital servos with encoders mounted on the rear of the motors, for the projectors instead of the analog potentiometer type that we were using, so he began to scout around for a local company to design and develop it. He found a guy in Austin who worked for a company named Astro Mechanics who said he would welcome the challenge. This was Ted Gage, the guy I was in school with at Rosedale Elementary in Austin. Astro Mechanics was out on Research Blvd. and they built medium to large telescopes and the associated controls of azimuth and elevation so Ted knew how to develop the projector servos. Ted made many trips to Garland and we made some to Austin to view the business and check his progress. That effort turned out extremely well and we wound up hiring Ted and he eventually became VP of Engineering. I also was responsible for bringing Vernon Showers on board from Collins about this time.

Another job I had was to design and assemble a small desktop type system based on the latest teletype console and interface it through a single board computer (became ubiquitous at that time) to the quadrature modulation system for digital HF communications. An adjacent department, Communications Systems, had developed the HF modem so I worked with them to develop the system. A very sharp programmer was assigned the task to develop the program for the machine and so far as I know, he made no mistakes in his programming, but he found several of my hardware mistakes. We built two of the consoles and connected them to HF transceivers for testing. This was a small and fun job that I worked part time with my other jobs. We also took the two consoles to Argentina to test and demonstrate for that government.

Data Systems Dept. of E-Systems

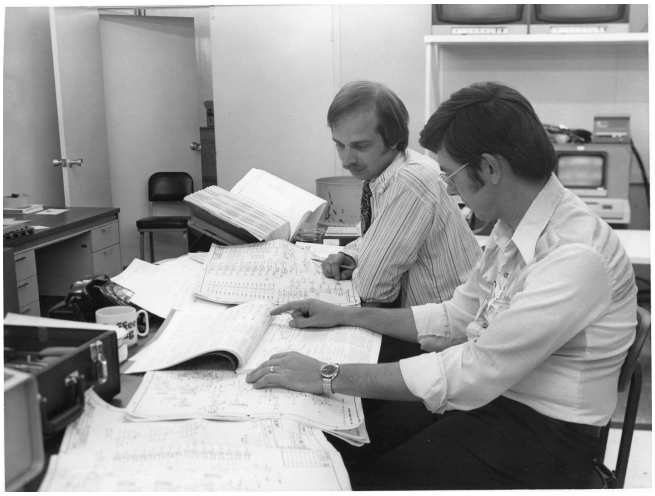
After I moved my family to 2005 Drake Dr. in Richardson, my Department's name changed from Display Systems Dept. to the Data Systems Dept. and we bid a system to the FAA to automate the Flight Service Stations. This was a "Proof of Concept" type bid and several companies bid the job, but we wrote an excellent proposal thanks to Bruce and his insights and won the contract. The contract was let for one million dollars and a schedule of one year with installation of a completed system in the Charlie Brown airport, Fulton Co. near Atlanta, GA. At that time ESY named the job AWANS; Aviation Weather And NOTAM System. The name was later changed to something else that I don't remember.

This was a challenging job, since the FAA Flight Service Stations had no computers and were using multiple teletypes to transfer messages. The flight briefers had stacks of TTY print-out on multiple clip boards. The only place in the FAA utilizing computers at that time (1970's) were the ATC's (Air Route Traffic Control facilities which guided commercial aircraft) and they were behemoth IBM mainframe machines which had been specially designed and cobbled together by IBM to run the ATC's. By comparison, our job was simple, but this was a giant step for the FSS's and no one knew the issues we would have to solve. I was assigned Lead Supervisor over the Hardware Group and Jim Metz was hired on and assigned Lead Supervisor over the Software Group. Fred Grisak was assigned manager of the effort. Fred was a long-time employee and came from the classified group. Fred was known in the company as a problem solver and mediator and his skills were well utilized again on this job. Ted Gage and I called him Frantic Freddie because he was always in a huff storming down the halls of ESY resolving issues somewhere with someone. However, the man was the most

tactful problem solver I ever met and everyone respected him including the customer; a valuable asset as it turned out.

Other members of the team were:
Hardware Group; Tom Calvert, Richard Dick, Vernon Showers, Joe Wakefield and others.
Software Group; Paul Funk and others clouded in my memory.

I have photographs of us working on the system. Actually, after we installed the first system in Atlanta, the FAA let another contract for a similar system for an experiment to collocate an FSS with an ATC and that system went into the Center at Leesburg, VA. It is that system I have photos of while in our lab. It was 9, 72” high 19” racks about 35” deep.



Lee & Richard Solving Issues With AWANS

The System & The Hardware Crew

The team had already selected most of the vendors in the proposal. We selected the TEMPO Computer from southern California because it had a 750 ns cycle time and a maximum core memory size of 64K 16 bit words. It was the fastest and largest memory mini-computer at that time. The system design contained two computers with shared peripherals; a new concept for the time. The idea was that if one computer were to run off into the weeds or die of a component failure, the system would not die, but switch all peripherals to the operational machine and continue to run, albeit slower. This turned out to be nothing but a dream and not possible. However, it turned out that having two machines operating at the same time was necessary because of the load on the system, so instead of redundancy, we had computing power. One machine was used mostly as a data gatherer and the other to operate the 32 display positions. Incoming data was gathered from several sources. From the National Weather Service; NWS, in the form of text and facsimile for maps and from other FSS's in the form of teletype data for NOTAMS, etc. We had a T2 line to the Weather Message Switch in Kansas City, MO connected on our end to a 9600 baud modem (highest speed available at the time). The FAX was brought in on a dial-up basis, depending on where the briefers wanted to look at the time and displayed on large elevated Conrac monitors which all briefers could see. All viewable data in the system was volatile and constantly changing, but was stored for historical and legal purposes.

In those days there was no "operating system" available. The software group had to begin with a design of such and each of the two machines had a different OS, because of their different functions. At the outset, there were many flaws which had to be corrected before we had a stable system and it was never very robust. We could have developed an over-arching OS which would be common between the two machines, but we only had a year to get it all done. Developing such an OS was in itself a many year project. Metz had his hands full.

The software design was centered around the FSS Operations Handbook, since that was our customer. Just after we got the system running for a longer period of time, Metz came to me and said that messages were being lost by the system. Apparently a message would come into the machine and then be eliminated and he could not determine what was causing it. I had just made a purchase of a piece of test equipment with capital funds provided by the company on an annual basis. This machine monitored and stored any kind of a serial data stream so that it could be reviewed at a later time, word by word. We decided to connect this machine to the incoming data and just see what was being sent. Almost immediately, we were able to determine the issue. The Handbook said that all messages were to be ended with CR CR LF (two carriage returns and a line feed, nothing else). It turned out that most messages were not ended that way because folks were banging on the TTY. There might be one CR or a hundred and there might be one LF or a hundred and if the ending was not exactly CR CR LF, the computer would assume a non-message and throw that message away. Metz explained this to the FAA and then had the programmers change the EOM (end of message) so that no messages would be eliminated. It was just such small things as this that drove us crazy and caused us to be late with the system and over ran the contract amount. This is where Grisak's expertise came to bear. Instead of a year and $1 million, it took approximately 2 years and $2 million. However, we did finally get through the acceptance test and installed the system in Georgia and the customer was happy with the system.

Then we had another issue to deal with that was unexpected. The FAA maintenance technicians were trained on teletypes and wire line connections and had no expertise with integrated circuits, computers, keyboard and monitors. They became adversaries of the system, because they could see the end of their jobs and being replaced by electronic types. So I went to work on a training course for these guys. They were smart techs, but just lacked the necessary training. I contacted every sub-contractor on the system to request the best training they could provide and I wrote a syllabus and training manual and integrated the whole thing into a multi-week set of courses starting with fundamentals given by ESY folks. This turned out to be a real asset and those techs quickly caught on and became our greatest advocates. They were also better at troubleshooting the AWANS system than our techs.

I've already mentioned Joe Wakefield. After we won the AWANS program, Fred and Bruce began to beef up our staff and one of the guys they hired was Joe. He is a likable guy and with a Type A personality. He was always ready for the next challenge and would work on whatever was needed. He also had a background in TV repairs and knew a lot about electronics and is a Ham, K5SMU. Joe and I hit it off immediately and he became my right hand and was responsible for getting me back on the air and on 2 meters. We spent many an evening having a cold 807 together.

Traveling with ESY

I've already written some about the initial travels with ESY for the "Dog and Pony Show," but there were other trips associated with Display Systems. I'll only mention one.

Madrid

One trip was to Madrid, Spain to repair projectors for the Naval school: Escuela de Naval. Before I went to work in the department, they had sold a set of projectors and ancillary equipment to the Spanish Navy for their school in Madrid. After years of operating, the projectors needed refurbishing, because the ball bearing races became worn and pitted. So Johnny Johnson and I flew to Madrid and spent a couple of weeks there getting the projection system up and running again. Johnny overhauled the projectors and I worked with the staff to better understand the system capabilities and help with alignment of the system. While we were there, we made some interesting observations. We ate breakfast and dinner on the economy, but we ate lunch each day with the Navy. There was an Englishman there working on a part of the system that the English had supplied and his name was Adrian. Adrian was allowed to eat in the Navy mess also, but because he was English, he had been separated from the troops and provided an isolated room all to himself. In the room was a nice table which seated as many as six people and on the wall was a large painting of the defeat of the Spanish Armada by the English in 1588. It was obvious that the Navy still held a grudge, because up until that point, the Spanish Navy had been king of the seas.

The Spanish tend to cook almost everything in olive oil and olive oil upset Adrian's stomach and gave him terrible diarrhea so he had talked directly with the cook and requested that butter be used instead. However, many times the cook either forgot or was purposefully trying to poison poor Adrian and he was served food cooked in olive oil.

It was interesting to watch the enlisted men come to muster each day just outside the window

in our lunch room. Now you must understand that the Spanish way of life is very different from that in the U.S. I don't know what time they would arise from slumber in the mornings, but there were no shops opened until 11 AM or noon. Then they would close the shops and have lunch about 2 PM and take a siesta. Then between 4 PM and 6 PM the shops would reopen and stay open until after dark, maybe 10 or 11 PM. Then the bars and entertainment would start about 11 PM and go for a couple of hours. One night we went to a typical song and dance show with flamenco dancing, jokes and songs and it began at 11 PM and let out at 2 AM. Anyway, the enlisted guys would be called to muster about 11 AM just outside the lunch room window and it might take them up to an hour to actually assemble and there was no sharpness such as standing at attention. They just lounged around sitting on the ground or leaning on their rifles and talking. Then they would be dismissed and go to lunch if they had showed up at all. That behavior certainly would not be tolerated by any branch of the U.S. military.

One evening we went to dinner in the Cuevas of Madrid. At that time, the caves were a popular hang-out for the young people especially of college age. It seems to me that they are located close to the Plaza Mayor. So a particular seafood restraint in the Cuevas was recommended to us and we were seated and tried to figure out the menu. I decided to begin with a seafood soup and follow up with paella. Little did I know from what I could decipher from the menu that the soup was supposed to be an entire meal and was not an appetizer. Well, I can tell you that I was really stuffed when I finished eating it all, but it was delicious. And the soup had every sort of sea critter in it and some still in their shells.

AT&T, Bell Telephone Co. and Western Electric

During my time with ESY, the largest monopoly in the USA was disassembled by the Federal Government and has subsequently been forgotten so I wanted to include the story here.

Telephone service and equipment was very different at this time. Telephones were black with rotary dials used to dial a number and they were attached by cable to the wall and no one but AT&T owned telephones. Subscribers rented the device monthly. Even after Bell Labs developed the two tone dialing system and push button phone, they were still attached to the wall by a cable. All telephone equipment was manufactured by one and only one company: Western Electric. WE was owned by AT&T as were the multitude of Bell Telephone companies. All telephone lines and poles were owned by AT&T; AT&T Long Lines. So this set of companies was a vertically integrated communications monopoly which was the largest and most powerful company in the U.S. At that time, with their foray into the computer business, it was thought that the company might take over the government if not the world.

The U.S. government spent decades putting together a way to break up the monopoly since it had become very strong with teams of attorneys. I was aware of it since my college days. Finally in 1974, the U.S. Department of Justice filed an antitrust lawsuit against AT&T and 8 January 1982 won the initial consent decree which began the breakup of the entire monopoly. This was the first step so that other companies could begin to manufacture telephones and set in motion a chain of events leading to today's cell phones.