A CHAMELEON OSCILLOSCOPE CAREER

By Robert “Bob” Beville

A.K.A. GLOWWORM 7-9-4

I grew up in central Florida and attended University of Florida receiving a BSEE in 1961 and MSE in 1963. I worked out of Patrick Air Force Base, recording the index of refraction of the airspace in the launch corridor, for 55 missile launches. Joined Tektronix in 1964 and first spent time in the Syracuse and Poughkeepsie Field Offices. Married Patricia Traeger 1965. I transferred to Product Evaluation in Beaverton and later worked in Design Engineering. I received an MBA in 1981 from University of Portland, While working at Tek I was an adjunct instructor at Oregon Institute of Technology and worked for the Supplier Quality Engineering group . I left Tek in 1999.

PREFACE

After seeing the story by Hal Lilywhite in the March 2017 issue of the TRVP newsletter, I too was inspired to accept Editor Bill Gellatly’s invite to share some of my Tektronix stories. I repeat, SOME. This is not a running diary or journal. Routine things, like casual customer calls, would be mundane and bore you. In addition, I include some curious stuff, sidebars, ‘footnotes’, and “OH, by-the-way”, tangential information and collateral events… Some of the flow of these stories will appear disjointed… and fragmented… Like this… If I am getting too technical, then do a fast forward… I am recalling stuff from back in the 1950s, 1960s and on.]

My first experience with a Tektronix oscilloscope was as a student in the lab of the Pulse Circuits course, EE Dept., University of Florida. These scopes were 535/CAs. We were first shown how to adjust the scope’s Stability knob and Trigger Level knob to obtain a stable display... In class we covered switching circuits: flip-flops, ‘one-shot’ multivibrators, free-running-multivibrators, Schmitt circuits, blocking oscillators, Phantistrons, Dekatrons and Nixie tubes. (Is that enough?) In the labs we built these circuits on an aluminum ‘breadboard’ with numbers of different type tube sockets on it. This was 1959, pre-transistors. We selected the vacuum tubes, studied their grid characteristics and solved for resistor values. Build it, apply power, and watch it operate using the 10X probe. (After the probe was first square wave compensated)…

It is later now. I apply and get a graduate assistantship in the EE Department. My assignment was to be a monitor in that Pulse Circuit lab. Again, the probe compensation, Stability and Trigger knobs. Once in a while I subbed for Professor Nelson Rosier to teach class. I

think he spent time in a laboratory up in the Siegel Building, a military research project, hush-hush...

Professor Wing, teaching solid-state subjects, occasionally got donation shipments from the early transistor companies. They came in the weirdest packages, early-improvised containers. (The Raytheon CK722 was so small hobbyists were complaining. Raytheon remounted them inside a larger package.) Wing began releasing devices to the laboratories, and Professor Rosier had to convert to teaching transistor flip-flops, etc… The labs now had to have low voltage power supplies. The B-PLUS voltage levels for vacuum tubes were not suitable. Therefore, we built our own supplies for the lab benches…

During exam weeks, there was some relief or diversion. A celebrity concert in the basketball stadium. I went to see Louis Armstrong, The Kingston Trio, Kai Winding, Fred Waring and The Pennsylvanians, standing room only for Peter, Paul and Mary, and Dave Brubeck. (Dave's wife actually conceived the campus concerts idea, bridging a lull in the concert scene). The poet Robert Frost recited poems in the Murphee Auditorium, he forgot some lines!...

As a grad student now, I got office space with a group of other students. One of the office-mates was an elderly woman who was a lab assistant to Dr. Robert A. Millikan on his Oil Drop Experiment in 1909. (BTW, Mr. Vollum named one of the roads on the Tek property after Millikan and Terman Road after Frederick E. Terman, the father of Silicon Valley, and author of one of our textbooks.) We grads also had the privilege of using the Engineering Building professor/staff break room. Its name was The Steinman Lounge, after U of F Civil Engineer David Steinman, who designed Portland's St. Johns Bridge. Large bridge photos covered the lounge walls. (Sidebar: he predicted the Tacoma Narrows Bridge design was going to fail; it did, didn't it)…

The National Bureau of Standards (NBS) contracted with the EE Department to record lightning strokes. An instrumentation trailer was installed behind the Gainesville Regional Airport (GNV), a second one at Cross City Airport (CTY). NBS also had similar trailers in Miami FL, Tallahassee FL, Boulder CO, Socorro NM and Maui HI. (Haleakala?) The trailers each had six oscilloscopes. Two scopes each were plumbed with 'periscope' ducting whose mirrors funneled their CRT screens to a Grass camera. These had 35mm film spools similar to early Hollywood studio ones. Outdoors were three antennas, a non-directional Isotropic, and two direction sensitive loops oriented for North-South and East-West reception. The antennas were cabled into the trailer. Five of the scopes were furnished with the Isotropic signal; each scope at a different sensitivity. A local lightning stroke signal might overdrive one CRT screen, but would be captured with some other CRT at a lower setting. Another scope was an ETC four-beam one. The directional loops were fed to it in an X-Y configuration to record the source direction of the stroke. A receiver tuned to NBS station WWV, the 24/7 time and frequency standard was fed

into another channel, only deflecting horizontally. The movement of the camera film provided the time axis as it scrolled vertically past this trace.

All sites were notified when to operate their trailers, simultaneously on ZULU Greenwich time. On a global scale, more than 2000 thunderstorms are in process at any one time. One hundred lightning strokes to earth per second! Mother Nature is just a voluntary signal generator, and Florida was the lightning stroke capital of the world!

There are thirteen types of lightning. The Streak Lightning, cloud-to-ground type, was the focus of this NBS project. [FOOTNOTE: Scott Stoddard, _Streaks, Flashes and Sizzle_ , AMERICAN SURVIVAL GUIDE, June 1998 vol. 20, no. 6, pgs. 24-29]…

I was able to operate a recording run alone and Prof. Marinus LaTour operated the Cross City trailer. Our local strokes were received by all other stations; the stations out west had locals that we received and so on. At the end of the recording interval, each site had three spools of undeveloped film. All were shipped to NBS Boulder. When developed, some images well-received by all stations were selected. A computer analysis (Fourier) of them generated East-to-West and West-to-East low frequency propagation/attenuation data. (The object of this project) This went on for a while until some atomic testing began out in the Pacific. The NBS suits showed up, saying "change of plans… the contract is terminated… ship your trailers to the West Coast. Thank you." It was realized what else these instrumented trailers could do… I had planned to do my Master's thesis on analysis of a local stroke and thereafter, with delayed sweep, capture it again after it circumnavigated Earth 132 milliseconds later. The project was over, just when I was getting to be nicknamed THOR, the Norse god of thunder…

Another assistantship assignment? Yes. Prof. Rosier received a request from a hospital doctor in Lakeland FL. after a high voltage power supply to perform Electrophoresis (Electrophoretic separation of proteins). The prof gave this to another graduate student (Marvin Moss) and me. Not a scope story, but cool. We designed his power supply, sending the MD our schematic with a parts list from Allied Radio (pre-Radio Shack), but encouraged him to shop for a regular manufactured supply for warranty and maintenance reasons. Never heard his decision…

Marv was very helpful with my electronics education. Instead of that physics stuff of solid-state devices and H-parameters, I learned more about designing amplifiers using 'beta', and other parameters. Together he and I designed a one-inch oscilloscope. Had to order the CRT tube from MULLARD in England. (Marv ordered an Innocenti sports car from Italy. He got worried when he was notified it was being shipped on the ANDREA GRITTI, sister ship of the ANDREA DORIA!). Seeing an article about "Coin Shooters" in an electronics magazine, we got interested in metal detector designs. This reignited my interest in treasure hunting since a 7th

grade field trip to some Indian mounds in a swamp. (File this for later). In addition, an article of ours was in RADIO ELECTRONICS, May 1966 issue, for a 3-6-9-12 volt power supply to service radios. A photo inside view showed all the components, with the outstanding large filter capacitors. The capacitor manufacturer, Sprague Electric, Quincy, Mass.., was pleased to see their brand name displayed- free advertising- and sent us each a log cabin shaped container of Log Cabin maple syrup.

That doctor's power supply design did not take long. My next assignment was to maintain the EE Department radar set. Designed by the Radiation Laboratory, built by Westinghouse Electric Co. in 1944, for the U.S. Army. This SCR-615B was operational, unlike the museum model given to MIT Meteorological Dept. The EE Dept. set was intended to view hurricanes across the state of Florida. My sponsor, Prof. Rosier, was featured in a POPULAR MECHANICS cover article, pictorially lashed to the radar tower in the storm… For his Masters, I assisted him to convert the set's random spark gap modulator (a design that cannot be jammed) to a stable periodic source (one that can be)…

While operating the set one day, I noticed a target on the PPI display. It was headed 'down the beam' right toward this radar hut. I stepped outside the hut when it flew low over the campus. Later I was to find out it was a Convair C-131 Samaritan, configured for Electronic Counter Measures (ECM). (FILE THIS FOR LATER). Operating out of Patrick Air Force Base in ECM support of missile launches, it had detected our radar signals and flew by to investigate. There was no report that our beam was interfering with any launch at Cape Canaveral. (There are variants of this airplane; a Coast Guard C-131, a Navy hospital transport and the one that produced weightless-ness-ness, the NASA C-131 ' Vomit Comet')…

Technicians may remember applying a soldering iron to a resistor to change its value to bring some parameter into calibration. On the radar set it was done by filing some Allen-Bradley carbon resistor, like, while calibrating the sweep rate of the Phantistron. Soldering iron heat, though, would continue to change the value; the Phantistron circuit had to be more precise. When it was dialed in- you didn't know what value it was – but to stabilize it, it was then coated with 'corona dope'… There was a requirement to monitor the current of the radar power supply, up there in the tower, to be viewed down here in the hut at ground level. A copper strap 'shunt' was bolted in series with the tower meter and wires across the shunt went down the tower to the hut's meter. I filed on the copper until I heard from Rosier in the hut, over a headphone set, when the ground reading matched the tower reading. (File this for later) And so on…

Tektronix Field Engineer Irv Chambers, out of the Orlando Field Office, frequently called on the UF EE Dept. and other campus sites. After one routine visit, I told him how much I admired Tek scopes. I had not graduated yet so he encouraged me- why not apply later?

After graduating, Prof. Rosier pointed me on to a job with Electromagnetic Research Corporation, (ERC), home office College Park, Maryland. I was to join a design group there to complete a contract for the Office of Aerospace Research (OAR). A senior engineer, David Ringwalt, flew down and met me at a motel in Cocoa Beach. He described the project and my duties. I first had to spend time at the Maryland facility. My trip to Maryland was on Eastern, a commercial C-54, to Washington National (DCA). A taxi to the Willard Hotel. A room for the night. Meet someone from ERC in the lobby next day…

(SIDEBAR: Supposedly the word 'lobbyist' was coined here, but not true. The story goes that President Ulysses S. Grant frequently visited the Willard, having cigars and adult beverages in the lobby. With this open access he was stormed by numerous legislators and favor-seekers. President Grant soon began to call these visitors 'lobbyists'. Lobbyists are documented back to early 1800s in Parliament, but the Willard Hotel PR doesn't mind keeping up the bogus story).

I obtained a room at a rooming house on Calvert Road, not far from the ERC facility, a company business park. I had weekends free. I took Greyhound busses to sightsee in the District of Columbia. I walked from the bus station to the Capital (down H Street!) only to find it closed on week-ends, not in session.

At the workplace you didn't have to leave for lunch. Midmornings a guy circulated by all the companies taking orders. Back around noon, he brought your lunch. Who does that nowadays?

I was teamed up with a digital engineer working on countdown circuits, time-mark generators and other logics. In these days, we're talking 1963, there were no integrated digital flip-flops, gates, counters, etc. A flip-flop was built with discrete transistors, resistors, capacitors and other discrete components mounted on a printed circuit board- no density at all. The circuit cards mounted into a rack mount mainframe/crate. The rear interface had to be wired from slot connector terminal to terminal to distribute signals around. Moderate networks meant many rack mounts.

When all this and other equipment was completed, it and I were relocated to Patrick AFB (The base that supports launches from Cape Canaveral Atlantic Missile Range) where the contract equipment would be installed in a C-131. (Now recall that "FILE THIS FOR LATER" note, the airplane was a C-131 in ECM configuration like the one that flew over the UF radar hut!). David Ringwalt and Dr. Katzin flew to Tallahassee to establish business licenses and operating credentials. I could charge supplies at a local electronics shop in Melbourne.

Here, a year after the Cuban Missile Crisis, I was told that the grassy areas beside the runways and tarmac were full of pup tents. A fighter-bomber flight was air-borne 24/7. Now, a year later, still goosey, don't even say "Adios", or "Buenos Dias".

Before I, a civilian, would be allowed to ride aboard an Air Force aircraft, I had to have a photo badge, a flight physical, get a pair of jump boots and flight-suit/overalls at the Base Exchange and qualify in a high altitude chamber test. Easy and easy. The high altitude chamber was at Pinecastle AFB (now Orlando International Airport (MCO)). This is the experience you'll have if your airliner is at altitude and a window or worse blows out. The cabin immediately gets chilly, fills with fog and your oxygen mask falls out from the overheads. NOT this chamber! No mask yet. You were given a clip board with some casual questions on it to answer as you began to lose consciousness from the thin air. Then an airman attendant fitted the mask on you… and you recovered. My identification badge had my photo and several colored threads laminated inside. They meant I was a contractor, had some level of secret clearance, and was only allowed in some areas with an escort.

Again, the focus of this contract/mission was to measure a property of the air- the index of refraction. (That's physics and meteorology stuff). To measure this, some pipes and baffles were mounted outside the fuselage of the aircraft, into the cabin, not the cockpit. Air flowed in through the front pipe, circulated thru a microwave cavity oscillator (the Refractometer) and out thru the rear pipe. The oscillator frequency shifted according to the value of the index (n= 1.000272 nominally, out to the fourth decimal place). The signal was mixed with a fixed stable one to produce a beat frequency difference. Still too high for charting or recording, the difference was mixed with numbers of crystals to finally reach a low enough signal for scopes and chart recorders. The chart recorder, for a permanent record to analyze, was a Honeywell Visicorder Oscillograph. See, it is still related to oscillography! It had heat sensitive chart paper that scrolled below a bank of mirrors. The mirrors were slotted in a huge magnetic block. The mirrors were attached to conductors driven by the signals you wished to measure. That current through the mirror conductor interacted with its magnetic field nearby and the mirror deflected, shifting its light onto the heat sensitive paper below. The heated traces cooled and became a permanent record. After the flight spools of chart paper were wrapped in light tight packaging for shipment to the home office where it would be analyzed. Another piece of gear on board was an AEROGRAPH CHART RECORDER. Inputs charted were: the compass heading of the aircraft and temperature and humidity from probes mounted outside near the airflow piping. Different colored ink ribbons were assigned to each variable. A mechanical drive made some hammer devices tap down on the ribbons to make a print impression on scrolling paper. In the cockpit window a 35mm camera was mounted, looking forward. The logic in the mainframe/crates, described earlier, signaled the chart recorder to 'tap' and to excite a rotary solenoid to click the camera shutter then advance its film—every so often…

Joining me was Jimmy Sutton, a technician that David Ringwalt knew from a previous research project. My job title was Research Director, an upscale name from sweeping out our quarters in the hangar to briefing the pilots on the flight plan to be flown using TACAN (TACtical

Air Navigation system) and DME (Distance Measuring Equipment) data. No mission had the same pilots twice in a month. These were different officers getting their four hours a month in to qualify for flight pay. In the briefing I also explained that we might encounter readings that would 'slam over' on the charts. This is where we had encountered an inversion, the interface between warm air, trapped from rising by a layer of cold air above. I would direct the pilot to dive or climb and vice-versa until the recordings 'slammed back '. The maneuver is called 'porpoising' The target area of the mission was to sample the airspace over the MISTRAM (MISsile TRAjectory Measurement system) site, located at Valkaria, Florida, a bunch of radar stations- nine in all- three, tree and three, were arranged in the shape of a 'L', located one kilometer apart again in the shape of a 'L'. Known as 'long base leg triangulation', the received radar echoes would resolve the position of a target (a missile), it was claimed, to three yards at 3000 miles- but that was predicated on a perfectly homogenous atmosphere. Since that isn't the case, errors were introduced- hence the purpose of our 'refrac' missions. The flight area was the airspace in the down range launch corridor (135 degrees true compass) before and after a launch. ECM technicians were also aboard if any unwanted transmissions that might cause interference with launch signals was detected. Our radio comm handle was GLOWWORM-7-9-4. (FILE THAT NAME). Near launch time, at say 'tee minus ten minutes', you hear on the Collins 618-T receiver, 139.05 MHz: 'UNKIND-ONE to GLOWWORM-7-9-4. (That was 'Shorty' Powers of Mission Control). 'Suspend your mission and vacate the launch corridor'. The pilot: 'Copy'. He would bank the plane over to the mainland and circle around until about 'tee zero', then aim the plane toward the launch pad. I viewed all those launches over the crew chiefs shoulder out the cockpit windows.

During idle times, when there weren't any launches. I scheduled just routine flights anyway. Arrangements were made with my contact at the base Office of Aerospace Research, Lt. Colonel Macolm Hormats. (Incidentally, a WWII pilot shot down over the English Channel. Great stories). He shared an article from QST magazine for a receiver circuit that could be tuned to the launch frequency (139.05 MHz) and placed in line with your car FM radio antenna input. So you could listen to the countdown, etc., while on the road.

About that SATURN 3. There was worry the engine's noise and vibrations would produce damage to the residences just outside the Cape property boundaries. To avoid damage claims again and again a border strip of homes was bought up. Turns out, the multiple engine noise was not additive, or scalar. It was vector constructed, not three times the noise of a single engine! AND all those white clouds you see during any liftoff- that is steam! The launch pad gets flooded with thousands of gallons of water to cool it down-to keep exhaust from disintegrating the concrete pad. I had a step-uncle that plumbed those water systems.

On a mission involving a SATURN 3, we were notified to suspend the 'refrac' mission and let the ECM techs take over. It seemed that some spurious transmissions coming from the Miami area were close to the Command Destruct frequency (408 MHz) – and that signals of the right shape might be interpreted as 'SATURN 3, blow yourself up'. So the launch was in a 'Tee-minus – something – and holding' mode. The ECM guys directed two passes over Miami and triangulated the location of a cab company whose transmitter was mistuned. I don't know how but some other assets got the transmitter shut down (FCC?). Now the countdown could resume. Headed back to Patrick when the launch went up, the SATURN 3, from Miami, looked like a roman candle from your neighbor's yard- that spectacular... Now low on gas, we landed at Opalaka Airport (OPF) to refuel. The pilot had to pay with his own credit card!

During another flight a hose on the refractometer piping ruptured and the cabin lost pressure. The pilot got woozy right away so the mission was cancelled and we flew back to base. During another flight a major was our pilot. In the briefings I explained the flight was to be 'on tract', to adjust the direction (135 degrees true) with corrections for wind drift, etc. His piloting was all over. Incorrect altitudes. Drifting off. Over correcting. He could not hit the ground with a rock! Jimmy and I fabricated an equipment malfunction and cancelled this flight. On another, we had taxied to Base Ops to file flight plans and pick up the IGLOO coffee Thermos and flight lunches. On the tarmac while going through the pre-flight check list, I took a seat portside behind the wing. During rev up of the engine I spotted something fly out the exhaust. I notified the crew chief right away. He put the engine back on tests and reported a cylinder in trouble. This cancelled the flight- BUT we still had our flight lunches! The plane was out of service and the engine taken down for repairs. The crew chief searched the area behind where this happened, finding a piston valve the engine had swallowed, chewed up and spit pieces out the exhaust…

A C-130 from Cambridge AFB joined us one time. It was super equipped with refractometers, cameras and recorders. Both planes were in the air that day when a missile blew up just seconds after liftoff. The smoke from the explosion had both heavier-than-air and lighter-than-air particulates. As they rose and sank the smoke began to define two inversions, an anvil formation above and an inverted anvil formation below. The science officer, Major Church, in the C-130 was excited, going nuts. He radioed UNKIND-ONE for permission to fly in the launch pad area to porpoise these layers. On another day some crew was exchanged, with me in the C-130. Seven hours we flew. Lots of porpoising. No acoustical insulation on the airframes! Only waxy ear plugs. Did not feel any air-sickness until at the dinner table that night. A U2 was also on this mission. Some things about the U2. It carries liquid oxygen, not bottles of compressed gas; an exchanger converts it to breathable level; it has only about two pounds of air differential between the cabin and outside atmosphere, hence the pilot's almost-space suit.

(You have got to see a U2 take off and land. As it just takes off it drops its outrigger wheel struts, getting airborne with less weight. On landing, it glides down the runway with two Airmen in a Jeep trying to catch up with it. If they are late, the U2's heavier side just tips it over to the pavement. The Jeep catches up, they install the wheel struts and the U2 can then taxi away.)

During that mission the U2 pilot asks Major Church did he want photos of these clouds… "How high are they?"… "Above 75 Angels". I later saw one of these photos; fisheye lens I'm sure, showing from the Florida Keys to Cape Hatteras.

Here are some interesting side stories… Another little function I had, once a week, was to visit a small weather hut down near San Sebastian Inlet. Check or change the batteries in the circular chart recorder and replace the chart paper. The hut was right close to the beach. Little did I know that out in the ocean a couple hundred yards was the 1622 shipwreck of the Spanish galleon Nuestra Señora de Atocha, and another wreck in 1715. And I have a love for treasure hunting, and practice it with a metal detector… SIDEBAR: Mel Fisher finally found the wreck in 1985, and salvaged the treasures, leading to the Historic, Abandoned Shipwreck Acts, and Military Remains Act.

Once a sergeant in the OAR office offered to let me accompany him on a trip to the launch areas. After he conducted his business we were on our way out during a shift change. Ahead of us near the exit gate the Air Police had pulled a vehicle off to the side. The trunk lid was open, rear end sagging low… During launches that are only test the performance of the engines, the satellite payloads are simulated with lead ingots. The sarge and I put that together- $6000 and six years prison!

Occasionally I visited the base electronics shop (PMEL). A technician there who placed orders for tubes and other components was adding part numbers from a –hp- Vacuum Tube Voltmeter parts list for himself. This reminds you of an episode of M*A*S*H, Season One, entitled 'Dear Dad', where Hawkeye and Trapper determine that Radar is mailing a Jeep home, piece by piece.

During onshore breezes the ocean salt content settles on the insulators of the utility poles, causing leakage in the form of radio static and visible at night, the arcing. The base fire trucks circulate around the base –no fires- just hosing the insulators off.

The warm Gulf Stream is a darker shade of blue than the rest of the ocean. Rising moisture forms linear clouds above it, called 'streets'. Whitecaps slap against it on a high windy side.

On one mission, since we were nearby, the pilot was ordered to land on Eleuthera Island and pick up some reels of data records. When we left it was high tide and the ends of the airstrip were awash. It was strange to see us taxi out into the surf for enough runway for a takeoff.

A group of Canadian Air Force jets were also at Patrick. On some of their flights they were landing outside the territorial United States. On their return the customs reentry laws allowed them to bring in a gallon of adult beverages- an IMPERIAL gallon!

As a base contractor with a badge, in casual street clothes, I could visit the Enlisted Men's Club. Or if I dressed up a lot more, to the Officer's Club. Sweet!

Some missiles blew up on or just off the launch pad. Another missile close by was being fueled and it caught fire, too. Two for one! The area cleared for a launch pad and block house isn't awfully large; the vegetation is palmettos, scrub oak and low brush. An explosion sets these on fire. The Air Police are out directing vehicles through the smoke, dodging the wildlife (deer and rabbit) and dispatching rattlesnakes.

Our crew chief (MSGT Lacy) was called into headquarters one day. He was given options: reenlist now for 36 months in Viet Nam, or get mustered out of service tomorrow. I don't know what he chose. (I searched names on the Viet Nam Wall… didn't find his.)

During the 1963 Hurricane season, a particular one was thought to be coming too close to Patrick AFB. Launches and our 'refrac' missions were cancelled. All planes were flown out of state to Warner-Robins AFB in Georgia. As luck would have it, the hurricane followed them…

On 16 November 1963, President John F. Kennedy visited the Cape Canaveral Atlantic Missile Range, where he was toured and briefed at the Saturn V Control Center by Dr. Werner Von Braun. He also witnessed a Polaris missile launch by the submarine USS Andrew Jackson (SSBN-619). The following week he was at Dealey Plaza…

Continuing, it is 22 November 1963. A number of airmen and I were hanging around the hangar 'gedunk' (Military for snack bar) when someone joined us and mentioned the assassination news. Several went with me to 'our' plane to listen to the cockpit radio (Collins 618T). Everyone at the Cape and base was extremely upset; JFK had just visited us the week before. The Melbourne Airport attempted to change its name for the President, but that went to Idlewild- the John F. Kennedy International Airport; the Cape Canaveral Air Force Station was renamed The Atlantic Missile Range….

After completing 55 recording flights, launches or routine-no-launch missions, I had this job mastered. I re-inspired myself to apply again to Tektronix. I stopped by the Orlando Field Office and spoke to Irv Chambers, (the FE who I met at the UF EE Dept.), and got my application started. Later, Chuck Buffiou and Frank Elardo, Atlanta region managers, came to Indialantic Beach, gave me an interview, an electronics exam and dinner at The Pelican. I was interested in an engineering position, but was persuaded to first be a Field Engineer (FE) to get a feel for the customer's needs and take that back to engineering later. It was arranged that I do ride-a-longs

with FEs in the offices: Orlando, Atlanta, Dallas, Houston, Riverside, two weeks each, eventually reaching Beaverton in time for the start of a FE training class.

On my first day on the job in Orlando, I crossed the street and bought 100 Shares of Tek stock, believing in my new employer. The stock went down a quarter point! Later, Chuck took me to a clothing factory outside Atlanta where I bought three suits to wear when calling on customers. In addition to these visits, I attended a region meeting held in Dallas. A guest from the US State Department spoke about Tektronix 'scopes being on The Strategic Commodities List. (Meaning: no sales to the Iron Curtain countries.) Weird, so were dentistry technical instruments and high voltage switch gear. The guest said that the Soviet countries were after high bandwidth 'scopes, and always attempted to get two of the same instrument, one to use and observe, the other to dissect… Another subject, a little paper weight replica of the 545 was shown. The idea got cancelled because it had no internal graticule!

Some of the notable visits with FEs: In the Houston Field Office I rode with an FE in oil country. One visit was to a Gulf Oil instrumentation trailer filled with 'scopes and cameras. There were oodles of seismic sensors (geophones) planted in the area, cabled into the trailer. As a novelty two sensors were placed opposite the ends of a nearby airstrip. They detected passing airplanes. With the known distance between phones and the time displayed on screen of their responses, these guys computed the planes speed…

In oil country there is a technology called 'Reflection Seismology' where seismic waves are generated by explosives down in a hole. They radiate through Earth and bounce echoes back from each rock interface, similar to RADAR. The recorded waves (mini-earthquakes) are interpreted by geophysicists to locate oil or gas reservoirs. Another oil company developed a clever non-destructive method to excite the shockwaves. A RADOME (contraction of RADar and dOME), the protective enclosure for a RADAR set, is anchored and weighted down above the target site. It is next filled with a gas. A spark plug in the top of the dome ignites the gas like a chamber in a HEMI engine. The ensuing shockwaves are recorded in the ordinary manner.

Nowadays a common energy source is 'Vibrosis'. A huge heavy vehicle has a base plate beneath its chassis. With a hydraulics system the plate is lowered to the ground. The hydraulics then elevates the plate and slaps it back to Earth back and forth- a repeatable shock source. This is no longer the one time shot of explosives or RADOME blast. The Vibrosis vehicle is relocatable so much more data can be recorded across an area.

Sometimes there is the question: what are the depths, composition and thicknesses of the strata we are drilling through? (An oil derrick's discharge is muddy, hard to interpret). One answer is a radioactive profiler; a radioactive source is attached to a cable and lowered down the drilled hole. A detector mounted above the source reacts to how much radiation, more or

less, the nearby strata was absorbing. Shifts in the responses defined the interface between different layers. The cable was metered so the probe depth is known. Reponses are then compared to known absorption material standards.

Another FE and I visited SPACE CENTER HOUSTON. One place was a huge space with hardwood floors like a basketball court. In the middle was a pedestal supporting a model space vehicle cabin. Pilots or the astronauts were subjected to rotation in the cabin until they experienced G-force blackouts. Yes, it was a basketball court. All buildings on this site, we were told, were to be built suitable to be a university campus. Should NASA ever vacate, they revert back to Rice University. In another lab, some engineers showed off a microwave walkie-talkie. You didn't read this. I was never there…

Moving on, I was next to spend two weeks in Riverside, Ca. I left Houston in the afternoon, heading west on Interstate 10. Dinner in San Antonio around sunset, I decided to keep driving, still I-10, still heading west. The month is June, the longest daytime hours of the year. After a while I began to see the dawn. I am driving west, and the sun is rising on my right! What? Not behind me in the East? I was confused. The sun coming up in the North? A full day at work and driving overnight did not help. Way later a map showed me how I-10 approached the Rio Grande and travelled parallel with it in a northwesterly direction. I got some sleep in El Paso. (I didn't regain my bearings until I saw the Pacific Ocean beyond LA.). Somewhere overnight, going through Arizona, I drove into a sand storm. The windshield got sand blasted; the eyebrows over the headlights were down to bare metal. Later I found a cup of sand, mud really, in the oil bath air cleaner.

In the Riverside area I joined a Field Engineer on a call to an aerospace company. They had been receiving a contracted number of 321 scopes, the small portable one. Because of some special requirements they were charged about ten dollars per line item for the parts list. As the last unit was about to be shipped the product line switched to the 321A. Did the buyer want to buy the new part$ li$t for ju$t a $ingle $cope? "No", he said. "Whew! Just deliver the scope. We will manage."

After some more customer calls I set out to head for Oregon. Up Interstate 5, I got my first glimpse of snowcapped mountains in the distance. Finally I reached Beaverton. I drove around the campus and located Building 74, Field Training, on Millikan. I found an apartment at Howard Manor, corner of Allen Blvd and Hall. There was a young woman living a few doors down… Hmmmm.

At my appointed 'show up time' I met Rollie Smith, Bill Stafford, Chuck Miller, Emory Harry, Jack McQuain, Ralph Livermore, Bob Sadelek and the famous 'den mother' Rose Avery. (See John Simmons' article in the TRVP News, August 2017). One of my 'classmates' was Helmut

Sonowala, to be the FE who called on customers in India. In a classroom at the whiteboard I was photographed, becoming an artist's picturization in the calendar (1965, I think). The coursework consisted of reviewing the catalog products and going over their schematics. Among the lab assignments, Rose gave us two kits of components to solder and build. One pocket sized unit was a time marker generator, to check sweep speed calibration, the other produced some arbitrary square waves, sawtooth waveforms, etc. to use as display signals while demonstrating an oscilloscope to a customer. They were constructed on those miniature ceramic strips. Another exercise was to try… repeat try, to tune the discrete component delay line of the 545 vertical amplifier. In a production plant we were shown how fast and how sharp the technicians could tune the transient response.

To get familiar with the rest of the company and operations FEs were likely to interact with, the class visited the assembly lines, finals, contracts administration, order processing, shipping and PTI, Product Technical Information. FE candidates were assigned duty in PTI trying to research technical questions received from existing FEs in the field. One of mine: Mr. Vollum was in flight somewhere and met fellow passenger Avery Fisher, founder of Fisher Electronics. In conversations, the 'peppered' finish of the aluminum chassis (singular and plural both the same) in Tek products came up. I was assigned to get Mr. Fisher the blueprints of the hazelnut blaster…About contracts, Ken Keyser mentioned that of all the states the original thirteen colonies were the most trouble to deal with. He said a customer in Brazil has difficulty getting his order through. "Don't show me a new catalog. My order is too far along in the pipeline. And I need to arrange a boatload of coffee beans headed for the states in exchange for my scope from the states".

About the time of my training, Building 50 was under construction. As described in the May 2107 issue, pile drivers were busy all over the building footprint. (A sub-basement still runs a sump-pump.) Next door, in Building 46, CRT Production started worrying about the vibrations to the CRT phosphor settling shelves. Turns out, exposed to vibration "These CRTs have great (smaller) spot size!" So they added shakers to the shelves.

Also in this time frame, Tektronix acquired Pentrix, Inc., makers of spectrum analyzers plug-ins for Tek scopes. Three leading engineers from Pentrix, Arnie Frisch, Larry Weiss, and Morris Engelson, joined Tek's staff in Beaverton. A lecture by Engelson was given to Field Training candidates and Training staff (7/24/1964). I took such good notes and diagrams 'they' decided to have it printed for distribution to familiarize field personnel. (Part-numbered 062-433.) Greatly simplified, imagine a radio. Replace the mechanical tuning knob with a circuit that can sweep across the receiver frequency band. Drive it with the sweep ramp of the scope. Remove the speaker and connect its output driver to the vertical input channel. The responses of the vertical will be the radio station carrier signals and sidebands. I said simplified!

Another FE Training class began, joined by candidate Bill Demmerle. Bill and I connected, as we had learned that I was to be sent to the Syracuse Field Office, replacing Kerm Fleck. Later, I am to be replaced by Demmerle as he lived nearby in Baldwinsville. It was agreed why don't I occupy their house until then. Sweet.

On December 28, 1964 there was a snow storm, ten inches, around the Portland area. A warm spell immediately followed. Flooding. Down on the swollen Willamette River, the River Queen Restaurant broke free of its moorings. They managed to grab it. On New Year's Day, 1965, Patricia and I were in Cannon Beach. The beach was littered with stumps, docks, hay and dead livestock that flowed out the mouth of the Columbia. (My Dad told my Mom: "I know why he stopped writing us. He's got a girl.)

When I left Beaverton for Syracuse there had been 45 days of overcast sky. I chose to head south for a while to avoid more snow across the upper states. In Weed, California I had to pull over and buy some sunshades.

In Syracuse I met Bill Kladke, Region manager, Lou Loebe, Assistant Manager, Bill Eppick, fellow FE, Joan Bashore and June Taylor, office secretaries. The field office was on Mallory Road, just outside city limits to avoid city sales tax added to Tek invoices. It was an office strip. One office neighbor was General Radio, (Later GENRAD and GR). A guy in that GR office renamed Hewlett-Packard, "Hewkie- Pewkie". Lou was my trainer, showing me the accounts I was to call on, protocols about handling customers, behaviors, arranging demos, writing customer call reports, etc. Major accounts in the area were GE, Chrysler, Crucible Steel, Syracuse China, Syracuse University, LAB Corporation, Grouse-Hinds and the local TV stations. My accommodations, mentioned earlier, were in Bill Demmerle's family home. On the way to work and back was 'The Clay Hotel', great German menus!

One of my calls was in a large industrial park that bought scopes and TV waveform monitors to install in their racks of television studio installations. This purchase agent boasted to me that he always got discounts on products he ordered, even on a single unit- and WHAT WAS I GOING TO DO FOR HIM! I realized and explained he must be talking about distributors who did shave some of their markup. We sell factory direct and policy was only to discount volume- sized orders. Later he placed a multiple quantity purchase order. Order processing responded with a legitimate volume discount. We then received his order for a single unit at that COMPUTED SINGLE discounted unit price! Cleaver of him. Of course, that was not the deal. That PO was not accepted. So he next asked me to fabricate a catalog with pumped-up prices so he could show management he was indeed, (apparently) getting single unit discounts from Tektronix. Cleaver again!

Before I left for Syracuse Patricia and I decided I would trade in this '55 Oldsmobile 98. I rode a bus to a Chevy dealership in Cortland, NY to pick up a Chevelle Malibu. Waited 8 weeks for the 327, versus 283, cubic engine. ($2807). Driving away, used to a heavier car, and in January New York weather, I almost flipped it. Trying to get registration, and a New York license plate, I wanted the car on my Florida Farm Bureau insurance policy. DMV said: "We don't think so." I had to drop my insurance company and insure with a local chartered firm. (Home-boy network?). Demmerle advised me to go with Liberty Mutual. Second best decision I have ever made.

A FBI agent phoned the office. He wanted to meet with whomever called on Griffiss Air Force Base, Rome, New York. That was me. I arranged an appointment, meeting him in the Officers Club there. Among other missions, he explained, this was a logistics base, a warehouse stocked with a variety of items and equipment ready to be shipped out to other bases. A number of 581 scopes had disappeared from a loading dock. Shown a catalog, I explained this scope was not operational without a plugin. He wanted me to be on lookout for any of them. "Sure will"… (FILE THIS FOR LATER). Another visit on this base was to a lab called the 'Quick Reaction Group'. They asked right away if I was carrying any steel wool, SOS or Brillo pads, because a radar set was nearby (?). No. They explained steel wool inside a waveguide is a killer. Saboteurs used it (?). Several instruments there looked familiar, like 545s, but were not. This was some instrumentation of their own design, constructed in our chassis and side panels, all hardware ordered from Tek. They did not disclose what these things did. On the airfield I noticed a familiar airplane, a C131 with ECM radar and receiver modules beneath the fuselage. Tail number 37816, was similar to 37794, the one I was in at Patrick AFB.

A small electronics trade show was held in Rochester at the Soldiers Memorial Hall. I was nominated for booth duty, my first, to demonstrate to show visitors the 'scopes and products. There is no learning something like having to explain it to strangers…

I called on the Rotron Company, makers of those thin profile muffin fans that Tektronix also uses in products. The building was full of sculptures and art. The guy I met there was bearded, in blue jeans and barefoot. I don't remember anything technical about this customer call. Bad memory? Yes. I CAN'T EVEN REMEMBER THE LAST TIME I FORGOT SOMETHING! This time period was 1965. In the same area, in 1969, there was WOODSTOCK!

A customer in Auburn was studying SCRs, Silicon Controlled Rectifiers, for windshield wiper motor controllers. To study switching characteristics, the 576 Transistor Curve Tracer was their solution. I delivered one of our demonstrators as a loaner, and like a dufus, I brought back the shipping box. Later when they notified me they were done with the Tracer I shipped them the box… empty box. On a later visit, "Didn't you receive the box?" The customer: "No box has

come." At the receiving dock, I enquired. "Oh, that box, it was empty, we threw it away!" Clumsy me.

At Syracuse University, I called on an engineer in the EE Department. He confused me at first with his name for plug-ins; he called them 'heads'. Further, he asked me when Tektronix was bringing out the five-something-something scope, some model beyond an existing one. How did I know? He meant like, the 547 after the 546, after the 544, or some such (?). He was guessing.

The experiences noted here took place from January to late May 1965. In early June a Tektronix-wide Field Engineer Conference was convened at the BROaDMOOR resort in Colorado Springs, Colorado. This property is outstanding. Built by Spencer Penrose during the gold mining era, he became the railroad magnate. The watering hole there is 'The Golden Bee', a pub that was disassembled, piece by piece, in England, shipped to America and reassembled on this site. It features a 'Yard' length beer glass (tube?); you are to try to drink from without spilling it into your face. The resort has numerous courts, golf courses, ranges, gyms, rinks, trails and shops, etc. for the hotel guests… Our conference had numbers of speakers and discussions of new products. One of the stories there was about a relocated FE, calling on his new account, a White Sands or the Sandia facility. He was inside a ways when his customer said: "You are not the Tektronix FE that visits us. You are an impersonator!" His region manager cleared him out of security detainment. Occasional breaks after the seminars let us go play. I, and others, signed up for trap shooting at a range up on the side of Cheyenne Mountain. It was kinda strange to be firing at clay targets with Colorado Springs out beyond the end of the barrel… I also learned there that Bill Demmerle had finished his Field Engineer training and would now replace me in the Syracuse Field Office; I was to join the Field Office in Poughkeepsie with Rick Kehrli and Vern Champeaux.

When the conference was over, with the timing just right, I drove up to North Dakota, married Patricia, and we honeymooned back there at the BROaDMOOR…

In Poughkeepsie (Timothy Leary country), an apartment agent located a home in New Paltz for us to occupy for the summer, a teacher's place while on school vacation. In the field office, I met Rick and Vern, and began interviewing applicants for my secretary. (Maria Leopold) Rick was to show me my customer's locations; he made me drive so I would pay more attention to the roads. My calls were to IBM facilities in Kingston, Peekskill, and Yorktown. Some other customers were Ferroxcube, Avon, Breck, Channel Master, Union Carbide, International Silver, West Point and Newburgh Air Force Base. Since my travels were often up and down the New York Thruway, I paid for the freeway tag to breeze through the toll stations. My car was enrolled in the Runzheimer Plan, to pay for company business mileage, so much per mile, plus a fixed amount for this model of automobile.

It was some policy of IBM facilities not to accept salesmen/vendors on Mondays. Fine with us; we used that time to arrange appointments, or make non-IBM customer calls. Ferroxcube, in Saugerties, makes ferrite toroids of all sizes, from beads to transformer cores. Tektronix buys one part number, 276- ?-? used in circuits to dampen ringing or suppress oscillations. On my first visit I was given a tour. Lots of scopes at test stations. Magnifiers mounted using our camera bezels. Grease pencil markings across the face plate to provide acceptance limits of each toroids switching performance. Another area constructed core planes. Operators strung wires: X, Y, and sense lines in a grid pattern through the bead holes by the hundreds. The finished product became a computer memory. Those circular LUXO fluorescent lamps with a magnifier lens were necessary to guide the wires through the holes. (Patricia worked here later; her eyes tested so good she was given the smallest bead size model to wire.) Later the tour was to their first toroid-forming machine… It was an old ASPIRIN tablet press! The die to form a tablet was re-tooled to form the toroid/donut shape.

Months later I got a call from a purchasing agent (PA) here in Beaverton. The Tektronix plants were out of stock of that ferrite 'bead' bought from my account, Ferroxcube. Production lines were down. Request: Would I please run up there and pick up a package. The PA had already notified them, arrangements were made. They were expecting me, the PO was already in place. The box they handed me was still warm from the sintering oven. (Powder metallurgy) I hurried it back to Poughkeepsie and put it on a little local Cessna at the Duchess County Airport bound for JFK. It connected to a Jet freighter bound for the West Coast. I submitted those freight charges in my later expense report. Then I heard from Tek Accounting that we were being double billed. I had my paperwork to support that we weren't to be…

A visit to West Point was interesting. I located the grave of Major Dade. He and his company were ambushed outside my hometown, the first of the 1835 Indian Wars, the site now named Dade Battlefield State Park. The graves in West Point go three deep! I saw General Patton's pearl handled revolvers in the museum. It was my first visit and I didn't know where the electronics shop was. A cadet I stopped popped to attention. "Yes sir. This way". The technicians in the shop welcomed me and we had some calibration discussions. One mentioned there was currently a class of cadets being taught about scopes and he could arrange a visit. I was willing. In the classroom, though, I noticed their scope was either a Hickok, Jetronics, or Lavoie, those 'Chinese copies' we were taking to court. I said I was not to touch any counterfeits. I instead drew a scope block diagram on the board and explained delayed sweep and the need for a delay line in the vertical channel.

Down the Hudson River, I called on a small electronics contractor. After introductions, he said, "Come here. Let me show you my new Tektronix scope." (Remember that earlier 'FILE THIS FOR LATER'? Pay attention.) I recognized the scope immediately as a 581. Closer, I noticed

the center cabinet spine where the side panels fit had four little holes in it. I had seen those before- where the owner/company/government mounted property identification/tracking plates. This area was blank. Down below the serial number slug WAS FILED FLAT! I soon completed my visit. Back at the Field Office, I notified my FBI agent contact. Later two agents showed up at the contractors shop, saying, “You have some government property. Thank you, we’ll take it now”. The agents brought it to our office. The calibration tech here removed the knobs and hardware, stripping down the front panel and recovering the serial number slug. (BTW, the serial numbers are always written on the front sub-panels, out of view). I understand the slug was sent to the FBI HQ in DC and X-rayed. The filed surface erases the number to the naked eye, sure, but the impressions into the slug creates denser material below them and the X-ray easily revealed the numbers! I was told that contractor bought the scope on ’Radio Row’, lower Manhattan. There was apparently suspicious paperwork about the sale and title, and it was a lead to the thefts… (Again, FILE THIS)

Newburg Air Force Base was the site of a Semi-Automatic Ground Environment (SAGE) station. I called on the PMEL, Precision Measurement Equipment Laboratory, that supported the calibration and repair of anything of a metrology nature, weights, standards and measures stuff. That extended to all the aeronautical instruments and radios of aircraft. While the Sargent and I were discussing scopes and calibration issues, I noticed the activity of a technician at his workbench: he sawed off a length of a broom handle. He drilled a hole in one end, drove a nail in it and sharpened the tip. A hole was drilled in the other end; a BNC cable end was snipped off and mounted into that hole. He wrapped all this with black electrical tape. I am not making this up! I finally had to ask, “Sarge, what is that E2 doing?” Sarge explained: they were trying to order an extra Tek probe from Base Supply. (Remember an episode of M*A*S*H? Season two. Trapper and Hawkeye wanted treat a patient but getting blood results from Tokyo would take too long. They wanted their own incubator. A supply officer told them they weren’t allowed one-it was not on the MASH BEL, Basic Equipment List.)… The BEL of this PME-lab did not allow an extra probe so they decided to fabricate a ’defective’ one to turn in for a replacement. That was allowed. Fortunately, I had probes in my brief case, and gave them some. I don’t know if they still turned in the ‘defective’ one.

Another issue the lab was having was about ordering matched amplifier vacuum tubes from Base Supply. They ordered the Tek part number, expecting a package containing two tubes. No. One part number. Base Supply shipped ONE tube! “OK, let’s order two of the part numbers. So what do we get? Two tubes separated, loose, not the matched pair package!” I could not help this right away, but did notify a Beaverton shipping group to emphatically label the packages with something like ‘Matched Pair-DO NOT SEPARATE’…

Along about this time the part-number system switched from six digits, XXX-XXX, to nine digits, XXX-XXXX-XX. The change was a boon to this lab. Sarge realized if orders were placed with Base Supply using the new format, it would not match anything Base Supply had. They then had to forward the order out to Tektronix. The lab enjoyed this for quite a while until Base Supply eventually caught on…

Here's another visit. Down the Hudson somewhere I visited a company making coaxial cables. The production area that I was led to had the machine that was last wrapping the cable in the outer black insulation cover, followed by the heat source that melted it into a uniform sleeve. Nearby was a 502 Dual-Beam Oscilloscope. The engineer there was testing a sample of the new material every production run. One input of the scope is connected to the fresh sample. The other input is connected to 'the gold standard'. Both were the same length. The two are held together and are whipped up and down. Both channels are at the same sensitivity, and sweep speed. The traces are displays of noisy signals. The parameter of interest is called 'squeak'. It's the ability, or misfortune, of the center conductor to shift inside the dielectric when the cable is flexed, producing a small emf-voltage spike. I had to ask the engineer, "How old is that 'standard'?" He turned to me with a big realization across his face. I guess I just destroyed him. The more the standard was whipped, the worse, the noisier it became. That was not too bad, but it was accepting squeakier product than was first expected…

In these times, every Tek product got shipped with two manuals. One for the end user and one for his calibration lab. Mike Columbo, of the Cal Lab at IBM Kingston asked me if I would accept an accumulation of them. This plant had hundreds of scopes and all personnel got familiar with their use- no need for these manuals. I said yes to accepting them. WHOA! Mike brought out a pallet full! I had them delivered to the Field Office, and inquired to Beaverton Finals about returning them. Shipping replied to not send them- it would be a lot of trouble to sort; some manuals would have mods and up-dates. So just recycle them. *And I was trying to be helpful*…

Another group at Kingston requested a demo of the 564 Storage Oscilloscope. I brought a demo, demonstrated it, and left it for their evaluation. I also left them the little booklet about the storage screen effect, including mention of the patent- the airtight patent! They returned it shortly thereafter. Hmmmm.

At Fishkill, I called on an engineer evaluating the specs of an overload circuit breaker- the trip-open times and the trip current level. I could have encouraged him to purchase our current probe. Instead, I recalled my AC and DC machinery labs at U of F where the current in motor windings was monitored. I suggested he obtain a similar millivolt meter with a shunt, calibrated in Amperes, across the terminals. Insert this in the ground return side of the breaker

and monitor the top side of the meter with the scope. Simple. The engineer liked that idea and said he intended to describe it in his formal evaluation report…

Inside IBM, there is a cost-reduction award system. How that is connected to Tektronix scopes is this: the calibration lab, on a periodic basis-a calendar basis, would bring scopes in to be re-calibrated. Someone realized that a lot of scopes sit thoughout the plants infrequently used, frequently idle, frequently just turned off. The cost saving suggestion was that since the scopes weren't operating the entire calendar interval, they most likely had not gone out of calibration, so they could be infrequently re-calibrated too. Running time meters were installed in the power supply and at the limit of operating usage duration time a switch shut off the scope.

I visited a NY State Medical facility, calling on a doctor. His operating room had a cat strapped down on a table, 'sleeping', with a small terminal sticking out of a leg muscle. Using the Tek 160 Waveform Generator products, the doctor applied a stimulation voltage to that terminal and measured the deflection, the kick, of the leg. This was the un-drugged baseline. After recording that, he took a syringe containing some drug and injected it into the cat. At some periodic intervals thereafter, the stimulant voltage was again applied, and the leg deflection again recorded. This went on as the drug took effect, levelled out and then began to wear off. A graph, deflection versus time, produced a profile of the efficacy of this drug. But *WHAT* about the cat?

Around the Field Office, the secretaries and I began to notice that Rick would frequently leave and seldom used his office telephone. Finally, he disclosed to Vern and I, *Sub Rosa*, that he had to go down the block to a payphone booth and converse with Beaverton. His secretary was married to an IBM purchasing agent, and Rick could not permit his conversations to be overheard. He was the Tek-IBM liaison involving a new scope. Every huge IBM mainframe computer site has a full time resident service engineer. His service scope at the time was the 5XX sized one, wheeled around on a Scopemobile. (IBM decided to produce a product to compete, sorta, with the wire- and tape-recorder- the model 224 Magnabelt Dictation Unit, *handheld* and *portable*. (Two in my collection) The recording media was a wide sleeve of magnetic treated material mounted in touch with a back-and-forth double helical drive like the old fishing reels, containing the recording head) Likewise, an IBM oscilloscope was to be designed for their service engineers, with a more *portable* size and with *mobility* for their engineers that traveled to smaller, non-resident sites as well. Eventually our attempts to compete became the 453 Portable Oscilloscope from the Portable Instruments Division, PID. Our 453 apparently had more bandwidth and was under the weight target.

Later, during my visit to the T.J. Watson Research Center, Yorktown Heights, I met scientist Paul Stewart. About the IBM oscilloscope bandwidth thing, he said he distributed an

IBM worldwide memo, asking, “Does anybody know anything about distributed amplifiers?” No one replied... In their cal lab, I was told about physicist Dr. J. B. Gunn, discoverer of the “Gunn effect” diode, used in microwave oscillators, like found in radar speed guns and automatic door openers, etc. His scope, they said, was so intricately modified by him, they didn’t know what or how to calibrate it. When it was due for calibration the notice was faked, signed off as completed…

Taking a break, here are some tangential sidebars. Field Offices were sent a case of calendars every year to hand out to customers, featuring product photos, artist depictions, and paragraphs about Tek activities, home and abroad. When the 422 was introduced, each office received a case of matchbooks picturing it. Occasionally there were trade show ‘trash and trinkets’. There was once a part numbered box of cigars, 006-XXX? for FEs to hand out. There is a part numbered camera tripod in the ROTAN product line, 016-0253-00.

The Channel Master facility near Ellenville, NY was big producer of your early TV antenna, and signal booster. (Pre-cable channels). Their ‘lab’ was outdoors in open property. The antenna design they were testing is mounted on a turntable, with a compass rose design on it. This is oriented toward an isotropic transmitter antenna in the distance, meaning the chief direction of the antenna is aligned with zero degrees of the compass and that this turntable ‘zero’ is aimed at the isotropic transmitter. The signal received by the turntable antenna is cabled to a spectrum analyzer. Frequencies in the TV bands, VHF and UHF, would not display well on a scope because of the rolloff of the scope’s own bandwidth. Amplitudes on the analyzer screen are recorded and the turntable rotated a little and amplitudes recorded again. Rotate and record, repeat, repeat. All these readings were plotted on polar coordinate graph paper to show the lobes of strong reception and the ‘holes’ of weak reception.

A Woodshole Institute customer brought in a scope that had taken in salt water while on a research ship at sea. Our technician evaluated the waterlogged unit and reported it hopeless. I wrote the customer a letter explaining the expense to refurbish it approached the price of new product and encouraged him it was better to do that…

A powder company, like dynamite, that I called on did not let me enter the gate until I opened my briefcase and revealed it didn’t contain any matches or matchbooks, or surrender them if it did...

An engineer from Columbia University explained a scope application involving two long tunnels, constructed at right angles. Lasers at the ends of the tunnels are beamed towards the junction into optics and prisms. Vibrations in the earth alters the travel distance/time of the paths in the range of the scope’s bandwidth or captured on a storage scope. Other

instrumentation got the signal beat down to be recordable by a chart recorder like USGS Seismic Monitors…

At IEEE trade shows with Tektronix and other electronics exhibitors, there were often requests to support their booths with our scopes and TV monitors. I, and other FEs, *were given* booth duty at an IEEE show in the NY Coliseum. Tek scopes were in the General Radio (GR) booth. Being the longest time exhibitor they had seniority of their booth location. The first thing you saw as you rode up the escalator to the showroom floor was the GR logo banner and soon their booth displays and our scopes. Sweet! A show visitor found me in the booth. (Recall that FILE THIS.) It was that contractor whose 581 was taken back by the FBI. He was beyond furious with me *and I owed him a replacement*! I could not help him except offer a 'pink sheet' of refurbished products. At the conclusion of the show some exhibitors decided to purchase our loaners to keep in their booth displays. Sweet again!

Another customer I called on, around Mount Kisko, was a pharmaceutical company. The pharma-engineer I visited was instrumenting a caplet-producing machine with strain gages that he connected to the 564 Storage Oscilloscope, first scope to use the DVST. First understand a caplet machine; a large circular plate has oodles of holes machined through it, in the shape of the caplet profile. It is below a hopper containing the drug and binder mixture, which is pouring onto the plate. Below the rotating plate is a set of dies, another set above. As these dies and the plate rotate, they pass over ramps that raise the dies beneath up into the cavity, and presses the upper dies down, compressing the powder in the cavity. Farther on in the rotation the upper dies retract, and the lower dies rise further and eject the caplet out of its cavity. A barrier beyond shoves the caplets off into a collection bin. The strain gage instrumentation monitored the activity of the ramps and dies; too much compression produced caplets that fractured; too little compression produced flaky, powdery ones. The engineer was after the shape and height designs of the ramps for the best formation of caplets. The storage scopes traces- the strain gage responses, gave perfect displays. Understand though, this was not done at production speeds. It rotated at slow-motion speeds to have time to study a single shot response.

So, these have been some *notable* customer calls and sidebars. This is an invitation to other Field Engineers to join me with their customer experiences. Soon, the Field Engineer 'Who Came in from the Cold'. My original desire and intention was to be in the engineering group back in Beaverton. My transfer came in June 1966…

By the way, a Jetronic oscilloscope- one of the knockoffs of the 545 is on display in the VintageTek Museum; also a 422-introduction matchbook and the FE's briefcase of vacuum tubes and tools…

Patricia and I took three days to go from New Paltz, NY to Beaverton, stopping in North Dakota to visit her parents, the in-laws. In Beaverton, we first stayed at the Satellite Motel, and later found an apartment at the *Chateau Ecole*, facing Building 39. Remember these places: The Speck Chicken?, The Berry Farm, Canyon Drive In, Shakeys, Wagon Wheel, White Elephant, Beaverton Drug Store, Heidelberg, The Wigwam and Bernard Airstrip? That dates you and me, doesn't it, 1966 or earlier.

My new job assignment began in Building 50, fourth floor, in Product Evaluation. The group managers were Leon Orchard and Rich Nute. Leon introduced Jim Hinze to me as my 'training officer'. This group's tasks were to take new products through evaluations, and participate in milestone meetings from Design Completion to Turn Regular. This also involved environmental lab treatments like do they meet specifications over high to low temperatures. How does the product survive on the 'shake table'? Using the GR Strobotac flash lamp, the frequency of flashes could approach a match to that of the scope's vibrations- to see resonances in the sheet metal panels or circuit boards that might cause fatigue failures. When Barry Gilbert and Les Larson's Knob Readout came out in the 7000 Series Mainframes, I got to build a calibration fixture to screen the IC chips that produced the millivolt, milliseconds, symbols, characters, etc., part number 067-something. When bandwidths of scopes were getting higher and higher, the need for a generator to check that bandwidth came up; one that was trusted to be level- that the scope's bandwidth was rolling down and not the generators. That led to a hybrid product with a General Radio jug/cavity oscillator merged with a sampling leveling circuit by Dennis Braatz, another calibration fixture, 067-0532-00, later, -01.

A little trick Jim Hinze showed me was about determining if a certain point in a circuit was sensitive. While watching a waveform at a high sweep speed you touch a node with the tip of a lead pencil. If the trace is disturbed that node is sensitive. I got a chance to use this on the 11B2 time base when the 647/11B2 was to become the 647A/11B2A with their vertical and trigger bandwidths increased. The components of the trigger circuit, including a tunnel diode, were mounted across a number of ceramic strips. As Norm Winningstad used to quote "Every picoHenry has a nanoFarad of its own", meaning that the length of component lead wires and the proximity of components to their neighbors and ground- they soon became parasitic components in the circuit. To improve the response of the trigger the influence of these 'strays' and parasitics had to be reduced. In the new design, components were connected in component –to-component (rat's nest) fashion instead of being wired up to ceramic strip nodes and jumpered to other components suspended across to the opposite strip. Oliver Dalton reviewed the design and construction technique, had a few suggestions and approved! Ceramic strip assemblies work well until you expect high, high frequency performance. (Think etched circuit boards, then surface mount) Also, in the test area, since the bandwidth was doubled, the cabling to verify it and one configuration, Channel One added to inverted Channel Two, became

sensitive to reflections or standing waves. Therefore, the cables had to be terminated. The test procedure was rewritten and issued to the technicians. It was not well received. Someone forwarded two 'test completion tags' to me, one signed by Donald Duck, the other Mickey Mouse!

Another product I was involved in later was the 1S1, Time Domain Reflectometer. Imagine this problem. Railroad telegraph cable was buried below the track bed. The ends of a cable were brought up to the surface so it could be coupled to the next cable and continue on back underground. Burrowing animals chewed through the outer sheath and dielectric exposing the center conductor. Moisture intruded there and degraded telegraph transmissions. So first, to understand Time Domain Reflectometry, think in audio analogy terms of a long, long hallway. The far end of the hall is closed, walled up. Now clap your hands, whistle, or shout from your end of the hall. A microphone connected to your nearby scope triggers on your signal and begins to sweep. At the correct sweep speed setting, the returning echo is on the screen when it arrives back at the microphone. The time between triggering signal and echo is the round-trip time. Half that time, multiply by the speed of sound (roughly 1100 fps at sea level, but also temperature and atmospheric pressure dependent) to calculate the length of the hall. Next, place baffles or large obstructions down the hallway, and try the same signal again. There will be mini-echoes from those obstructions… Some middle schools do this during Science Fair. Now, let us speed up the timeframe to nanoseconds and faster. The output of the 1S1 was an extremely fast pulse step signal. Applied to cables, the echo waveforms from the pulse edge (like the echoes in the hallway) are interpreted as capacitive loading, inductive loading, moisture deterioration, mismatches, discontinuities, or an open or a short circuit. The time axis indicates the one trip time out to the reflection. It required, though, knowing the velocity of propagation of the cable under test to determine the exact meter, centimeter, etc… the absolute length out to the fault. (In a similar instrument in the high voltage transmission field, they can see reflections from every transmission tower.) The evaluation was the routine involvement in the temperature chamber, on the shake table, high to low line voltage behavior, participation in the Steering Meetings, calibration procedures and assistance to manual writers. Talking about involvement, I once dreamed I was that pulse going through the Vista Ridge Tunnel in Portland. I felt discontinuities tugging on my energy as I flew by. I woke up when I hit the 'termination'.

Once your instrument was in production you also had to monitor it. Problems from the assembly line to the finals and calibration areas came up and you were to attend to them. Once, in a product, a tube-transistor hybrid, with the first ever transistors in it, a UK military contract had the 'frozen parts list' requirement, and could not handle modifications. Unlike recalls or Technical Service Bulletins (TSBs) at an auto dealership, trouble began when

frequency responses of the transistors were getting better and better, creating oscillations in the circuits. Finals had to resort to a number of devious fixes…

It was also the case where the front panel of the new instrument had to pass through an approval by the Nomenclature Committee. Most labels like Volts/Div and Time/Div were routine, but occasionally a function's term was unusual. The design engineers had a suitable name for it, but thought the Committee would have to change something. Therefore, some awful name was selected and placed in the diagram by the graphics designer. The committee persons would pounce on that and eventually, with coaxing, get around to the desired term, thinking they had come up with it! Approved!

Somewhere in this life, I began to get concerned about the Iron Curtain, ICBMs, Soviet TU-4 bombers, atomic bombs, hydrogen bombs, and the EMP, the pulse of energy that wipes out all semiconductor junctions. You know, when the excrement impales into the air-moving machine. With computers then useless, what is your recovery? Back to slide rules! I began collecting every slide rule that I could, even Addiators, AccuMaths, and other early mechanical calculating devices. I could open up a store.

It was on April 18 1968 that Robert F. Kennedy came to the Assembly Cafeteria, Building 45, on his presidential campaign tour. I met him and we shook hands. On June 7, the flags on the Tektronix Industrial Park were lowered to half-staff.

Since I was a lab instructor and occasional substitute lecturer in class for the professor at UF EE Dept., later giving flight plan briefings to the 'drivers' at Patrick AFB, doing scope demonstrations to customers, I got comfortable speaking to groups. At the same time, I was drifting more into digital subjects, being a hobbyist building circuits from those *Radio Electronics* magazines, using RTL Resistor Transistor Logic, later TTL logic devices. Here in the Tektronix Education Program (TEP) there was Len Bell teaching Boolean Algebra and Logic Design. (Len was the author of one of the Concept Books {available in the VintageTek Museum} When Len passed away, TEP instructors Harry Stewart and John Sheppard recruited me to teach that class. Even had Jean Auel, the Clan of The Cave Bear author, then in Manuals, as a student. I expanded the class into Boolean Algebra, Logic Design and Sequential State Machine Design and soon heard from Dr. Miller of the Oregon Institute of Technology (OIT) satellite campus on Harmony Road. I began teaching there, part time, evenings, as well as being the lab instructor/monitor. I wrote lab experiments like the controller of the Ford Thunderbird turn signals or an intersection traffic light controller. One remarkable memory of an evening in the lab was about an experiment to design the controller state machine of a small un-manned delivery vehicle that followed a metal strip around the factory floor. As the vehicle occasionally drifted off the foil, a left side or right side sensor detected this and made corrective moves to steer it back to the track. This was during the Gulf War. We had a TV on in the lab watching

coverage of *Operation Desert Storm*. During some coverage about the GBU-28 laser-guided "bunker busting" bomb, some of us realized how similar that guidance controller was to our lab's strip-following vehicle state machine. The laser target input replaced the metal strip, and one state machine drove the rudder vanes and a similar state machine directed the elevator vanes to keep the bomb steering toward the target.

Back at the Tech Center, I soon joined a design team for one of the 7000 Series plugins. Bill Peek, Bruce Hofer and I were to replace the analog ramp-pickoff method used in the delayed-sweep/A-Intensified–by-B circuitry. "The 7D11 Digital Delay Unit… can assist the oscilloscope user in need of accurate, low-jitter sweep delays or by having delay-by-count applications." Seven and one-half digits display in the CRT READOUT of the 7000 Series Mainframes. A HF oscillator switches into a frequency divider at the time that delay counting is to begin. While the helidial of the analog sweep delay was in control of the three most significant digits, the 7D11 Fine Delay (0 -100 ns) is only concerned with the two least significant digits of the measurement, making resolution to one nanosecond possible. The circuit boards in the plugin were partitioned into the HF timing circuitry board and the digital counter one.

Who visits me at my workbench one day but…Mister Vollum. He often made rounds like that. Often with some good product ideas. He noticed how full my digital counter breadboard was, 36 TTL chips. He drilled me on why was it so crowded with ICs, pointing to his digital watch. I explained how the ICs were as compact as could be selected, being LSI, Large Scale Integration already.

On another tangent, some visits of guest lecturers were scheduled. Dr. Walter Brattain of Bell Labs spoke in the Building 50 Auditorium about how he and fellow scientists John Bardeen and William Shockley invented the first transistor. The semiconductor material they needed was silicon and germanium. However, there was difficulty-finding sources. He said in order to get the germanium, it required going out into the foundry/smokestack industries and scaling up inside those stacks, scraping off the soot, and having it refined.

Another speaker was Bob Widlar, the creator of the first integrated circuit operational amplifiers at Fairchild and National Semiconductors…

Someone even scheduled showings of the TV series, "VICTORY AT SEA"!

Now recall that controls like vertical or horizontal position of a waveform on a CRT are *displacement* adjustments. In the 7D11, a novel control set the time delay or number of events desired. This novel control was 'Forward Reverse and Throttle', a *velocity and direction* adjustment. (Do you recall a control on the VCR-Video Cassette Recorder? You dialed fast-forward, fast reverse, or slow motion.) Bruce designed the variable velocity circuit. Phil Lloyd, Mechanical Engineer, did the front panel knob, a shaft and potentiometer suspended in

mechanical as well as electrical center. Off center was detected to determine the direction of the displayed count. All these designs were submitted to the Tek Patent Office for review. They became United States Patent Number 3,843,873, assigned to Tektronix, awarded to Bill Peek, Bruce Hofer and I. Credits must go to the knob control creator, Phil Lloyd, ME, overlooked on the patent application. Sorry, Phil. The Tek Patent Attorney was Adrian J. LaRue… When I later saw the velocity/direction control on a VCR, I thought, "Are they infringing our patent?" and called the Tek Patent Office. After some review- there was no infringement, the patent protection term had expired! The November 1972 issue of the TEKscope promoted the 7D11 in one of its articles.

A visiting engineer from Sony/Tektronix came by with circuitry of their intended digital delay unit. (At introduction, he gave me a present- a clutch purse for the wife. I had been informed it is customary to present something to these visitors in return, like, a fifth of 12yo Glenlivet Scotch) In their circuitry schematics, I detected a flaw. Their delay trigger output was derived from a de-multiplexer IC. Consulting a TTL Data Book, I saw that the propagation paths/delays for a count to its output was longer or shorter than others. The difference in delay of one period of a waveform to the next would differ by the value of its counts propagation path through that IC. The 7D11 method was to load the 9999ninety-nine's complement of the count desired. (Simple example: a desired count of '10' would load the number '999989' as its beginning. Nine clocks or events later the count reads 999998. That eight is binary 1-0-0-0. On the next clock/event, the one-bit, forming binary 1-0-0-1, completes the '999999', and it asserts and becomes the triggering signal… regardless of the desired number… always the same propagation delay when it is time to output. This straightened out the Sony/Tek visitor.

Similar to the out-and-back mode of a Time Domain Reflectometer or radar display, a mode switch called NORM-ECHO divides the time clock by two. The readout is not altered so the one-way trip time is actually displayed.

Later, with the timing board removed and a revised front panel, another product became the 7D10 Event Counter/Delay Unit.

Throughout some instrument manuals occasionally Al Hill or Garve Beckham, graphics/schematic drafters, placed a 'cartoon' character in a schematic related to some technical term or label…The Wizard, Top Gun, Mountain Climber, Back Porch Generator*. Garve did the 7D11 'cartoon', a snail sitting on the bits 01011, signifying 'delay' and 'eleven'.
*There are 20+ characters on the VintageTek museum website: https://vintagetek.org/?s=schematic+cartoons

Since new products are introduced at major trade shows, there had to be some kind of way to demonstrate the 7D11's time or event delaying capability. Using the output of any

repetitive signal generator would not do. One waveform looked just like another, so you could not distinguish if there was any time or event difference. Instead of being periodic, a stream of pulses was needed that were somewhat random in nature, so that portions of the sequences were different from others. This was done by using a Pseudo-Random-Binary-Sequence, PRBS. These are popular in encryption coding, passwords, bit-error-rate generators, white/pink noise generators, frequency-hopping spread spectrum, Bluetooth, garage door remotes and guess what... SLOT MACHINES! The 7D11-demo-plug-in used a linear shift register with some outputs tapped that fed to logic that provided the next input to the register. Example: a 4-bit shift register, having 16 states, connected in its PRBS maximum length sequence configuration, would shift through 15 states* before repeating: 1-1-1-1-0-0-0-1-0-0-1-1-0-1-0…repeats… The demo outputs were Clock, Index and Sequence. Three consecutive logic ones in the register, were gated together to generate an index signal for the 7D11's start trigger. This simulated the one clock pulse of a disc index track. Then the PRBS stream could be looked at either by counting through clock pulses (Event Count Mode) or Delay by Time mode. *The 16th state, 0-0-0-0, is a null state that would 'hang' and never shift anything but logic zeros…

With the timing board removed and a revised front panel, the remainder just became the 7D10 Event Counter/Delay Unit.

Feedback from Tek customers and users, Field Engineer customer call reports, and other channels occasionally mentioned a 'need' for some feature or capability to achieve a particular solution. One of these needs came from some digital equipment servicing areas… expressed this way: "the scope's trigger modes are internal or external. The external trigger input has only one BNC connector for a cable or a probe. JUST ONE! I need to initiate a trigger on a combination of logic levels from a number of different points around my product. In other words 'a multi-bit trigger- trap box'!" The answer to this was first a part-numbered accessory, consisting of four little probes coming from an array of logic gates. Slide switches and probes used the resistor color codes 1,2,3,4, brown red orange yellow. The switches selected TTL level logic 1, logic 0, or 'don't care'. When the probe's levels matched the switch settings, the trigger signal outputted. There was also provision to cascade the first unit into a second that formed trigger output on an eight-bit word or byte. It was a circuit board, four switches, four probes, wraparound panel, output BNC, cascade input BNC, and two endcaps.

Along came Burroughs Corporation with a request for a portable service tool: a frequency counter and voltmeter, companion to the 453 portables. The contract was for only 50 units. Then, on a low budget, tooling costs were avoided by selecting existing packaging and hardware. The cabinetry of the miniature 211 scope was adopted with the numeric seven-segment LED readout displays mounted in the CRT screen area. The line power supply, just a work order in the Model Shop, used front panels, sub panels and rails of the TM500 single

width plugin stocks. With this attention to improvising packaging without mechanical engineers, I realized my experience and resume in things other than electronics was a little lacking. To round myself out, I began taking my breaks and lunches down in the model shop. I cultivated some machinist friends and was allowed to use the machines… I used scrapped metal material, making things to learn how to use the vertical mill, grinders, buffers, Rotex multi-punch, break, and 'sweet': *the lathe!* The design group players were Project Leader, Neil Robin; Voltmeter area, Allen Hollister, Marshall Borchert; Counter area, Bob Beville; ECB Layout, Carl Stromberg; Graphics, Jim Gerakos.

It was soon realized there was indeed something about the need for digital equipment servicing tools. A product group was formed: the 800 series. The Trigger-Trap Box was re-named the 821*; the Burroughs unit was named the 850 TECHAID* these were the infants of the 8XX DIGITAL ANALYZER* line of instruments. *These are on display in the VintageTEK museum.

I was interested in transferring to the TM5000 group about this time. There was attraction to design a bit-error-rate testing product. Jerry Shannon sort of recruited me. When I moved into Building 39, with Jack Millay as manager, Dave Rule had just left the company and I was selected to fill in on his project, the PS5010 Power Supply. The whole product group, TM5XXXes, were doublewide plugins. A power supply, voltmeter, frequency counter, function generator, etc. were all programmable on the GPIB General Purpose Interface Bus, Standard IEEE 488. GPIB became very popular; the whole equipment world got on GPIB with intelligent instruments and capabilities. With groups of instruments, generators, printers and other features, a system could be configured to do any number of functions, hands-free. Since we all had to get familiar with the GPIB, several instructors were recruited; Harry Stewart, John Sheppard and I began teaching design and software engineers. The GPIB system has to have a program director. The director, a product called the Controller, tells each instrument what setting it is to take, what to do with its inputs or outputs, etc. For example, here is a system to test Zener diodes: to measure its Zener voltage, decide whether it was in tolerance, and eject it to the GOOD bin, or REJECT bin. In a conversational format, this would go like this: Controller: "Power Supply, assume (some) voltage. Connect output to Fixture" (…Power Supply complies…). "Voltmeter, become (some) voltage range, connect to Fixture" (…it complies…). "Fixture, select next device"* (…it complies…). "Voltmeter, report Zener voltage to Controller" (…Voltmeter complies…) The Controller makes the tolerance decision and says, "Fixture, eject the device to the GOOD (or REJECT) bin" (…Fixture complies…). The Controller loops back to the "Fixture, select next device" code line, and on and on… *Notice that the loop does not begin at the top of the program because the Power Supply and Voltmeter do not have to be re-programmed.

It was around this time I applied and was accepted into the Tektronix sponsored University of Portland Masters of Business Administration (MBA) program, along with many other Tekkies. Details are thin. I think we only had to pay for the textbooks. Evening classes. Since we all would have driven to the campus, increasing the parking problem, the professors, instead, made the trip to Beaverton. However, Accounting was on the UP campus. The prof told us about the classroom: "Debits by the door, Credits by the window, but be careful if the final exam is across the hall!" In place of a computer course in the MBA curriculum, I was permitted to do a directed study. Dr. Richard Gritta, the finance, investment professor was my director. In preparation for this, over the previous year, I collected the little column, in Sunday's business section, of the Money Market Funds interest rates and maturity averages. The collection was of brokerages, like Smith-Barney, Dean Witter and Merrill Lynch; insurance companies, like Kemper, Zurich and Equitable; and some stand-alones like Columbia Funds, totaling 19 funds. Over the year covered by the collection, rates rose and rose and rose, then began to decline with Chairman of the Federal Reserve Paul Volker's help- a laboratory stream of data. To conclude, my study showed that brokerage money market funds seemed pretty casual about the attention they paid to investing your account's cash. After all, they were focused on stocks. The insurance company money funds were lots better. Their focus was on your policy premium$. Ca$h. They seemed to grab the shortest maturities as rates went up, and the longer maturities as rates declined.

Dr. Gritta also studied the airline industry. A formula using the data from airlines annual reports was a predictor of their bankruptcy. The "Z-score", widely tested and accepted, has a 72 percent accuracy in predicting bankruptcies two years in advance. I found the originators book, Altman, Edward (September 1968) "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy", and started applying it to Tektronix' annual reports, taking a few minutes per year. No biggie. The formula has five components, with 'Total Assets' in the denominator of four. That, Total Assets, was quite a drag on the Z-score, keeping it in the grey zone. (The zones were "Safe Zone", "Grey Zone" and "Distress Zone"). This was a popular posting. I heard that even Debbie Coleman and the 'Corporates' followed it.

In 1977 Tektronix acquired the Walker Road property, a former book company. The S3000 Systems Division, Microprocessor Development Products and TM5000 groups were relocated there. I am now in the FG5010 Function Generator design group. Dennis Hall, manager; Steve Rice, software, ramp/saw tooth/sinewave circuits; Tom Hill, output circuits; me, N Burst circuits, configuration and interface/motherboard. All submitted their circuit's inputs and outputs to me and what-connected-to-what. I arranged the motherboard connector assignments and some motherboard layout paths. The product became very crammed. The circuits had to be fitted on approximately 8-inch by 4-inch boards. This led to six circuit boards and the interconnect board. The product we were competing with was a "hewkie-pewkie"

desktop/rack size function generator; its circuit board measured 600 square inches, like ~24 by ~24 inches! Indeed, hard to compete with…

I am moving on… I left Walker Road and joined a group in Building 47. The 2465 oscilloscope plant was in Clark County, C1. It needed a test system to calibrate it. Dick Westlake and his group operated the GenRad circuitboard testers in Bldg. 47. He recruited Lou Sowa, Warren Fink, Jim Baker, Ken Hampton, Frank Hovanic, Joe Gamble, George Fagg, Marlene Pfaff and me on what was named the Multi-Purpose Test Station, nicknamed 'Muppets', with concern about infringing on the children's TV program on PBS. Multiple GPIB products were assembled into a four bay desk level workstation: three-instrument rack cabinets and the operator position. The 2465, instrument-under-test (IUT), display monitor, and printer were on the station top. The GPIB controller was by Fluke; input sources were -hp- Signal Generator, Wavetek Multifunction Calibrator, Waveform Synth Function Generator, Winchester disks, barcode readers and some sources not found on the market: in-house designed 067-fixtures: Programmable X-Y Pattern Generator, Fast Rise Pulse Generator, and Programmable RF Attenuator. These instrument signals were fed through a huge Programmable Microwave Switch Matrix, (another 067), then to the IUT. The IUT, a 2465, had inputs Channels 1, 2, 3, 4, External Trigger and Z-axis. Its outputs were A Gate, B Gate, Channel 2, and of course, it was coupled to the MPTS system through its GPIB port.

Some marketing people in the Measurement Systems Division learned about the instruments contained in the system and insisted that Tektronix products be used instead. Dick Westlake defended the choices saying the specs of the 2465 needed sources and measurement abilities five or more times more accurate than a 2465 spec. On a tour through the plants, Howard Vollum and Larry Mayhew visited the MPTS area. We explained these choices. Howard stated that was all right with him. He said, "Do not compromise if our products don't meet your specification-goals."

The MPTS stations were transported to C1, the plant in Clark County, for the 2465 production line. We Beaverton employees had to commute to Clark County. There were eleven systems built, (two eventually were shipped to the Guernsey Island plant with Mike Swenson and Douglas -?- sent to set them up and train their operators.)

At C1 I was elevated to manage the MPTS support group, over Mike Swenson, code writer; Douglas -?-, MPTS station technician; Joe Gamble, Manual writer; ? Fabre, code writer, and others I forget. There was an occasion where one product had numerous failures. Douglas knew what to fix but ran out of the replacement part. The order to the manufacturers parts department came back that they were closed for inventory. I called their president. I told him we were a million-dollar-a-day product line and that his parts department needed a laxative. I then said, "Do you understand my problem?" He answered. "Yes." I came back with "Do you

understand your problem?" There was a pause. Then "Fax me your purchase order." We were soon back up and running…

Soon a shift in manufacturing process began to be adopted and embraced. Led by Joe Conrad, the shift was called Kanban (Japanese for billboard), a scheduling system for lean manufacturing and Just-In-Time (JIT) delivery. In a sideline assignment, I helped an industrial engineer configure a trolley system for the 2465 production line. It was built with a slight decline to it. The 2465 chassis assembly started at the first bench, then was placed on a platform on the trolley. The platform rolled down to the next assembly station. More components are added, put back on the trolley, and it rolls on, and so on. Along with this, the CRTs and Mu-metal shields arrived Just-In-Time. Metro carts were filled with cardboard boxes for just the amount of units as the days schedule required. The empty cart gets prepared with plugs in the boxes that signifies "Don't fill these for the next order". Next day, the delivery truck brings its filled cart, and takes back that empty one. That is three carts circulating, one in use, one empty, and one being filled.

The Just-In-Time system helped reduce stock and staging areas. In an attempt to eliminate a staging area of the main circuit board, it was taken right away from the solder wave area to assembly benches. Soon after the product was completed and turned on, it was found that some potentiometer/trimmer adjustments were erratic. This happened on all main boards. The boards from the former staging system did not have this problem. I had a technician remove some of the erratic trimmers for me. I pried one apart and placed it under a combo camera/microscope. There was the problem. It had absorbed water in the rinsing area of the solder wave process. But, as I viewed the trimmer with the microscope lamp on, the lamp heat quickly evaporated the droplet! I wanted to document this with the camera, but not of a dry dissected trimmer! That was not evidence I could present to the supplier. I contacted the manufacturer's rep and made an appointment. At that meeting, I showed him a photo of the trimmer with MY droplet of water in it. The photo and several 'wet' trimmers were forwarded to the manufacturer. A report came back of their analysis and solution. The dies that formed the O-ring seals were worn, making deformed rings that allowed water to penetrate into the trimmer body. The dies were re-tooled and O-rings were dissected and inspected during each production shift.

On another detail, I obtained a blue print of the 2465 manufacturing floor and plotted the locus of the movements of materials: boards, sheet metal, components, staging areas and hardware. That led to some rearranging the areas to more linear flow and reduction of floor space.

Since I was one of the commuters, I was occasionally asked to deliver, return or pick up something at/to the 'other' site. Once I passed by the Technical Center, Building 50, where I

noticed the automobile spaces, reserved for the Board of Directors (BOD) members, were full. Hmmmmm, there must be a Board meeting going on. It was just lately that I had read *The Hunt for Red October*, where communiques were exchanging between the subs and Washington D.C. SO IT BEGAN! I started posting sightings of Directors and other executives on the Cyber/UNIX mainframe, in the tek.rumor newsgroup. Using the military communique style, the inverse of the traditional inner-office-communication (IOC) format, the posting said:

ZZZZZ

/// 0001Z ////

FM: GLOWORM-7-9-4 ('FROM' came first to get the receivers attention!)

TO: BODWATCHER COMMUNITY

RE: GLOWWORM HUMINT SIGHTING

MESSAGE FOLLOWS

1. GLOWWORM STATION RECEIVED REPORT FROM XXXXXXXX, A CONTACT WHOSE REPORTS HAVE BEEN RELIABLE IN THE PAST.
2. CONTACT STATES THAT WHILE PASSING BUILDING 50 AT 1830Z, CONTACT OBSERVED PARKING SPACES FOR BOARD OF DIRECTORS WERE OCCUPIED WITH VEHICLES.
3. INTERPRETATION- REPORT IS ASSIGNED LEVEL A1, TRUSTABLE SOURCE AND BELIEVABLE SIGHTING, SUGGESTING THAT BOARD MEMBERS MIGHT BE GATHERING.
4. APPRECIATION- VERIFICATION OF MEETING REQUIRES SIGHTING REPORTS FROM OTHER ASSETS.

MESSAGE ENDS

GLOWWORM SENDS

/// 0035Z ////

I had adopted my comm name from the time I was at Patrick AFB. I became the 'handler' of other employees, 'operatives', who joined me with their sightings and movements of executives and officers. We kept this up until I closed GLOWWORM STATION in December 1998, accepting the Dave Corson 'exit/separation opportunity'.

Moving on… Since I was handling more component quality problems, some reorganization got me into a Supplier Quality Engineering group, led by Joe Burger, and fellow employees Harry Anderton, Martin Baggs, Earl Aune, and others.

A remarkable assignment I was given was about a high failure rate of the hybrid attenuators in the 2465s. Joining me was Tony Nelson, an engineer in HCO, Hybrid Circuits Operation, and the attenuator supplier. Numerous failures were mailed back to us from the Field Office Repair Centers. However, a handful of broken attenuators did not give any clues. An experiment was designed to find out if the problem was a total product problem. The inputs were put into their 50-ohm terminator mode. Ohmmeters were connected to each input. The front of the instrument was elevated a centimeter at a time and dropped. Landing on its own front cabinet feet had no problems. A new scenario was next tried: A customer that places the scope on a shelf or a workbench with the front feet unsupported… and it is the cabinet that lands on the bench surface, not the front feet. Jackpot! The Ohmmeters showed the 50-Ohm circuits were open. The attenuators were removed from the main board. Our broken units were similar in appearance to those from the field. It was tried and proven again. Experiment findings and conclusion: Attenuators break when the wrap-around cabinet gets deflected inward, behind the front cabinet feet and impacts the close-by hybrids on the main board. OKAY! You can explain how it is breaking. NOW FIX IT! The wrap-around cabinet material has a seam, centered, that completes the closure of the cabinet. In future cabinet production, the seam was relocated so that it was no longer opposite the hybrids. For field repairs, a wide rubber bumper, with a gap to straddle their existing cabinet seam, was produced. An adhesive was applied with a peel away covering to apply it to the cabinetry. Given a part number and a field mod number, hundreds were shipped to the repair centers. Glenn Pickeral and ? were flown to a military base to mod those scopes already stored in a large logistics warehouse. In an HCO employee assembly, Tony and I were recognized for the solution. Mark McPherson gave us a “you done GOOD” certificate and a Dave Friedley coffee mug

Building 73, Board Build Operations, (BBO), was short a supplier quality engineer. I was relocated there by Harry Anderton to join Pat Hamilton. At first, it was a little intimidating to work in a ‘huge’ factory with hundreds of circuit boards, thousands and thousands of components and many assemblypersons. I began to circulate and introduce myself to line managers, buyers and lead persons. A pager or the public address system would call me to some workstation where a problem was occurring. Also, between the Finals Plant and BBO, a document called CORRECTIVE ACTION REQUEST (CAR) could arrive, saying some component, board, or assembly had such-and-such a problem or defect. The CARS were recorded and tracked. The ‘CAR CZAR’ would bird dog the recipient until the problem was resolved. If a problem was discovered in BBO that the Finals Plant was not aware of, it was I to inform that product line. It was often that I stepped into a staff meeting, unexpected, of course. Since I was from BBO, not a staff member, they knew I did not bring good news. My nickname became “Doctor Death”.

A problem that plagued the 2200 Series line forever was thrown at me. The power transformer on the main circuit board was always exiting the solder flow line with one of its two cores cracked. An option to install the transformer after solder flow had been suggested. That was discarded; there would be a lot of labor to block the circuit board mounting holes before solder flow, unblock them after solder flow, install the transformer and hand solder it last. The mechanism of the cracking core was explained by a study of the movement of the board through the flow line. Cores just after the solder wave were intact. Cores, beyond, after the water rinse and blow dryer blast had cracked. This had to be a reaction of exposure to heat followed by the shock of the rinse and air, involving expansion coefficients or something. Opening a transformer showed that the core and both outer members were on the same plane, flat and level with each other. I applied and got permission to perform a production experiment, with notices on their main boards to report any problems in the final product having power supply issues, and the likelihood of being recalled. The experiment dealt with putting thin pad-like material in between the core faces. These units completed the trip through the solder line without any breaking. The pad allowed some compression and not core surface-to-surface reaction. It apparently did not disturb the magnetic flux/transforming operation, either. Not a word or report came back from Finals. I submitted a mod to the product line.

This job had a lot of multi-tasking. Among other activities was dealing with the buyers of the numerous components in the plant. Sometimes there was checking on stock at the receiving dock, whether the count was correct, the part number correct, etc. If non-performing material or rejects were involved, a DMR (Discrepant Material Report) and RMA (Return Material Authorization) document was generated; credit for returns and orders for good replacements. The buyers had a little mantra: Be as nice as possible and as nasty as necessary. My mantra was “I know where you are parked, and you only have one spare tire!”

Here is another sidebar. I do not recall when but I once visited “WACKY-WILLIES”, a surplus equipment/component store in Aloha. While there, I saw a 10-foot long slide rule like the TEP instructors used. I wrote earlier that I collected slide rules, but that one was too much. Not for my collection. On another shelf, I passed an oscilloscope. Oh! Someone must have surplused out a Tek scope. Really? No, it was not a Tek scope. It was one of those unauthorized en. The Office sent someone to Wacky-Willies to purchase it. It was a Jetronics model. It is now counterfeit 545 copies. When I got back to Tek, I phoned the Patent Office and explained what I had seen on exhibit in the VintageTEK Museum. (It happened that in all the court proceedings of the suits against Hickok, Lavoie and Jetronics, Tek had not acquired an exhibit of any of those knock-offs.)

Along about now there was the adoption of the ISO 9000 Certification, a framework around which a Quality Management System could effectively be implemented. Prior to ISO 9000, the Supplier Quality Engineering (SQE) process would be, say in the case of a discrepant component, first, a PA announcement by the Building Secretary: “There is a supplier quality component alert. Read your e-mail”. An e-mail containing the part number, date code of that problem part, who is reporting the problem and nature of the problem is sent to an e-mail list of line managers, lead persons, stock room personnel and its buyer. The alert document was also posted on a bulletin board in the main hallway. Instructions were to look up that part number, find assemblies that contain that part and check the stockroom shelves for that part. Bring all subject material to an isolation area. Inspect for and identify all subject date coded items. Notify SQE of the findings and inventory. The supplier quality alert process eventually got its own ISO 9000 procedure document.

In order to reduce PA system announcements requesting my attention, I devised a flag system in several areas over the manufacturing floor. One in the Stock Receiving area, the others in the Assembly areas. When the flag was pulled up to the ceiling, it could be seen from all quarters, and I could respond to their problem. I did recordkeeping of the problems, incidents and their resolutions. I filled over a dozen journals of part numbers, date codes, and descriptions of the trouble, the resolution and names of the persons contacted.

The receiving/loading dock, near the stockroom area had a lot of traffic in empty boxes, containers, trays and machine insertion component tubes. Some were headed for the landfill. Some for recycling. A few suppliers were contacted about recycling their material. A few ‘barrels’ located near the dock began collecting some trays and IC tubes from the component insertion areas. I arranged shipping occasionally. Disappointing though was the fact that component tubes were formulated with different polymers, and could not be recycled (melted) together.

More multi-tasking. Electro-Static-Discharge (ESD) is a concern in all electronics manufacturing areas. Employees wore ESD discharge heel straps and coats. Delivery carts had chains underneath dragging on the floor to discharge any static. All employees involved in the assembly areas occasionally had to attend an ESD certification course, with an exam to check their understanding. The current employee that taught this had left the company. Since I had dealt with lightning (major static discharge) on the U of F lightning stroke collection project, I asked Terry Keller if I could teach the course. Yes. I was already mentioning ESD in the OIT Boolean Algebra/Logic Design classes that I taught where the lab students also handled ICs. I revised the exam and included some affirmation questions. Using overhead transparencies, I covered the precautions of handing integrated circuits, checking the integrity of your heel straps and use of the conductive foam for transporting ICs.

A BBO employee who had left Tek for a position in the Oregon State Lottery (Megabucks) Headquarters in Salem contacted management about my static discharge training. There was a need to give their gaming machine technicians ("slot-techs") the same lessons. I arranged, for a consultant fee, to give one-third of the techs, each, the training in three sessions.

John Walner, the BBO plant manager, held an assembly every accounting period, displaying how the company was performing, how BBO was doing with its metrics and initiatives. Other speakers had announcements. One was the compliance officer who came with three hats, becoming one person for each of her agenda items. When she was through, my report was next. I explained she had more personalities, so many she qualified for her own group insurance! My report was about recent component alerts, the DMRs written on defective components, the Corrective Action Reports received and/or closed. Once, a supplier and I had a language barrier problem. Using a transparency, I revealed to the assembly how the defective component was labelled… a Frowny Face; the good component had a Happy Face! Big laugh from the crowd.

Occasionally the building went through a fire drill. Some monitors held the doors open and checked that everyone had exited the building. All groups had a specific station where they were to assemble. So, this is a fire drill. Let's practice this drill thing. I handed out some book matches to some members at our station and gave them instructions. On my mark, we did: "Ready…Aim…FIRE!" and struck our matches... Now, that's a FIRE drill!

Pat Hamilton was assigned to the circuit board manufacturing plant in Forest Grove, and a temporary hire joined me. Pat Bolen. He was shown the manufacturing floor and met many folks. I introduced him to the buyers we dealt with, with vendor's component problems. He soon mastered the part numbers system and could answer problem calls without my shadow. We struck up a friendship and went hunting that season. Later Pat was replaced with a permanent hire. Len Deddo. Same-o same-o. Introductions, tour, part number system, buyers, etc.

There, I have gone through 42 years of my experiences with, on and around oscilloscopes. That's the CAREER part. I managed to be versatile and flexible. That's the CHAMELEON part. I sought out more education with seminars, etc. and took the Tektronix supported MBA degree at the University of Portland. I taught a number of subjects, Sequential State Machine Design, computer languages and GPIB-IEEE-488. I had managed to be over looked during numbers of layoffs, downsizings, RIFs (military for Reduce-In-Force), scale-backs, phase-downs, early out offers, workforce reductions and other synonyms. Then, in the fall of 1998, there was the Dave Corson Separation Opportunity. Patricia and I did the math. With the sick time and vacation time cash out package and some Tek stocks, she and I decided it was

time. I filled out the paperwork and turned it in. I informed my people in BBO of the decision. The separation interval was on that 60-day notice law, so all of us separation volunteers had from November 1 until December 31. There was something deliberate about this timing so the payouts and W-2s would be in the following year. The goodbye lunch location was my choice, Helvetia Tavern. Rena Toliver gave me the 35-year service award, a Bulova watch. I gave someone the material to continue posting the Tektronix Z-score when the annual reports come out. Being funny, I decided to do one last post of the Glowworm bulletins on the tek.rumor newsgroup. Here it is:

ZZZZZ
/// 0001Z ////
FM GLOWWORM-7-9-4
TO BODWATCHER COMMUNITY
RE GLOWWORM STATION CLOSURE
MESSAGE FOLLOWS

1. ELINT STATION XXXXXXXXX MONITORING VHF 139.05MHZ IN VICINITY USAMR CAPE KENNEDY INTERCEPTED THIS TRANSMISSION: “UN-KIND-ONE” TO GLOWWORM SE-VEN NIN-ER FO-WER. SHORTY POWERS OF MISSION CONTROL ADVISES GLOWWORM MISSION IS AT FI-YIF DAYS AND COUNTING. SUSPEND OPERATIONS AND EVACUATE AREA.”
2. PERSUANT MESSAGE ABOVE GLOWWORM STATION IS BEING CLOSED DOWN. AMUSING CLANCY PARALLELS ABOUT MOVEMENTS OF CINCTEK (the company president), STAFF AND BODS (board members) ARE SUSPENDED. CLOSURE IS CONSISTANT WITH RECENT INACTIVITY DUE TO INABILITY TO COMPOSE HUMOROUS BULLETINS OUT OF CURRENT EVENTS (meaning the layoffs). CONCURRENTLY, POSTINGS OF ANNUAL ‘Z-SCORES’ ABOUT THE COMPANY’S PRONENESS TO BANKRUPTCY ARE SUSPENDED.
3. OPERATIVES AND CASE OFFICERS OF GLOWWORM NETWORK ADVISED TO DESTROY AND DISPOSE OF CODEPADS, CODEBOOKS AND CIPHER MACHINES.
4. OPERATIVES DESIRING TO COME IN OUT OF THE COLD ADOPT YOUR PREARRANGED COVER IDENTITY. AT OUR PREARRANGED TIMES AND DATES, STROLL ALONG PENNSYLVANIA AVE. FROM TENPENN RESTAURANT TO WILLARD HOTEL- AGAINST THE ONCOMING TRAFFIC. WHEN APPROACHED GIVE THE COUNTERSIGN TO “IS THIS THE WAY TO FORT MARCY PARK?”
5. CASE OFFICERS, DESIRING, TAKE THE TOUR OF THE FLETCHER CLASS DESTROYER AT ANACOSTIA NAVY YARD. ON THE POTOMAC SIDE OF THE DECK, ASK A COOKS MATE “IS THAT COFFEE GROUNDS DOWN THERE OVER THE SIDE?” (It really was!) AFTER CORRECT COUNTERSIGN, FOLLOW HIM.

6. GLOWWORM SENDS GOODBYES AND GOOD LUCK. YOU WILL STILLWATCHED.
   MESSAGE ENDS
   /// 0031Z////

I receives messages of ‘sad you are leaving’, ‘Good Luck’ and ‘tek.rumor won’t be the same’ from Hank Lunki, Richard Kurschnor and Steve Jensen.

THE END