

The following is a *greatly* abbreviated history of my 36-year career at G.P. which I'd intended on presenting as a going away talk... until it grew far too long. *Not wanting to distract those searching the net for business reasons, I've precluded this turning up in company, or in name searches by removing the company's name (except in JPEG format) as well the last names of my co-conspirators.* -clw

THE ROAD TO METAMORPHOSIS

This *end of term paper* is about me. Selfishly omitting the creative and productive efforts of others, it barely mentions the friends, mentors, and coworkers without whose help my career would have been less than successful. What *is* distilled here are personal highlights; just a few special events that stood out well above the normal day-to-day; times when work didn't seem like work at all.

My life is proof that timing and luck play a large role in one's career. Ending my formal education after just a year of Junior College could have been quite an impediment, but I was fortunate when I married Laveta, and lucky again when I started working for Boeing in California as a flight-line mechanic on B-52's, a position that gave me an opportunity to move into *Quality Control* at the Marshall Space Flight center in New Orleans on the *Apollo* first stage. I was only 21 years old and an inspector on the Saturn-V! It was a great experience... though, after *Hurricane Hilda* blew through New Orleans, we decided we really preferred California!

I returned to California as an inspector in a large aerospace machine shop in Pomona. The job required a working knowledge of Trigonometry- which I managed to teach myself. In my pencil and paper calculations (there were no small calculators in the '60s) it was easier and faster to use the logarithms of trig functions... so I learned about logarithms too.

The Army drafted me in '66 but I fooled them by enlisting instead, figuring I could get a better deal that way- and perhaps I did. For the next three years Laveta followed me from California to Washington State, Indiana, Augsburg Germany, and Kansas. I ended my term of service in September of '69 at Ft. Riley KS (where Sharon was born) then drove to Tacoma and

found a job as an inspector in a small machine shop on the tide-flats. A few months later, the company couldn't make payroll and I was back on the street.

I walked through our company's front door in February of 1970, a young father needing to put food on the table. Lou, the owner, hired me that day. Talk about luck! I wasn't just touched by the finger of fate... she came right up and kissed me on the lips!

Laveta and I settled into the Oakland area just up the hill from our old "Nallely Valley Pickle Plant" location on 35th street. To save money, I walked to work. Starting out in the shop as a shipping clerk, I worked my way up to an inspector in Quality Assurance. I was lucky again since that Boeing inspection experience gave me a shot at the QA slot.

There were only two of us in the department (my boss and me) so I needed to be versatile. And it was that requirement for versatility that forced me to stretch. To earn my keep I needed to learn a great deal. I almost wore out the Tacoma city library's chemistry section and I became fluent with a slide rule! It was like being paid to go to college! I "discovered" statistics, regression analysis, conservation laws, the relationship between stress and strain, section moduli, thermodynamics and Newtonian physics, instrumentation, gas laws, the Stephan Boltzmann equation and Poisson's ratio. The more I learned, the more I realized all the things I didn't know, so it was back to the library. I learned to calculate stoichiometry in chemical reactions, perform titrations, determine points of inflection then automate them. In order to understand Infrared Spectrograms, I learned the wavenumber assignments for chemical bonds and functional groups, and so could infer from the infrared ab-

sorption spectra how molecular “parts” stretched, wiggled, and rotated! Just like the books said- *molecules were real!*

In the late 70’s, with Perry’s help, I designed our smoke chamber using optics from a World War II gun-sight collimator, along with other lenses from Edmond Scientific. An aluminum wheel holding neutral density filters that I purchased from Eastman Kodak calibrated the chamber’s *optical density coefficient*. The output was inconveniently nonlinear, but it worked. The equipment turned out to be remarkably accurate in quantitatively determining smoke emission from burning foam and was used for years.

In the old plant there were short intervals when we had no chemist. Those were neat times because I could play chemist. The plant supervisor would keep production going and I could experiment.

I tried producing low density Polyimide foam using Isocyanates rather than the normal route using Amines. I attempted to obtain adequate mix times by loading the catalyst into molecular sieves. To release the catalyst at the time and temperature where it would be the most effective, I added inorganic hydrates starting with Sodium Tartrate Decahydrate and worked my way up to higher temperature hydrates.

I’d mix all the ingredients together, pour the mixed liquid into a mold, place the mold in a large steel pressure vessel and close the door, then turn on the two large 2.5 KW microwave units mounted on top. The microwaves entered through two waveguides. As this was a home-built unit, there was some concern on the part of shop personnel that exposure to microwaves leaking past the door seals could cause male sterility. But the manufacture’s representative (who was onsite to verify our installation) explained to the shop crew that their fears were overblown.

The only way microwaves could make you sterile was by heating (for example *cooking your balls*). Thereafter I conducted my polyimide experiments more or less alone. I did have a microwave leakage test instrument – so I wasn’t worried. Once the new chemist arrived, I went back to QA and did inspection and testing things. The Polyimide project ended up a failure- but I became confident at making chemical calculations, learned a great many things that did and didn’t work; my capabilities grew, and it was fun.

I bought some parts from Boeing Surplus and others from a chemical supply salesman that had them in his garage and from the pieces assembled two instruments. The first was a *Thermal Analyzer* that I used to identify phase transitions and the temperatures at which foam cured or decomposed.

The second instrument was a *Thermogravimetric Analyzer* that could accurately determine the weight loss characteristics of small (10 milligram) samples as the temperature was linearly ramped up to 650 deg C... at which point the aluminum pans holding the samples melted and dropped through the Nichrome wire frame. The Electrobalance was so sensitive to vibration that it was affixed to a 600-pound concrete stand. Then, from a kit, I assembled and soldered up a Heathkit© 1mv strip chart recorder to record the output of the Electrobalance.

I did my own glassblowing and modified the apparatus to run tests in flowing air or in flowing Nitrogen. That’s when I discovered that Oxygen in the air united with the pyrolyzing foam products to produce char! There was more char produced when foam decomposed in air than when it decomposed in Nitrogen! Pete, the foam expert at Sandia National Laboratories in Albu-

querque ran a confirmation analysis for me. Even Pete was impressed.

In 1980 we moved to our present location at 4910 Burlington way. I remember walking through our new 150,000 square foot building the day before we began our move. It was completely empty, and I was sure that we'd never fill it. There were then three of us in the Q A department.

To evaluate rigid foams used in transportation containers that protected nuclear materials from roadway accidents, I elected to use our "Oil Burner" originally designed by the Federal Aviation Administration for simulating inflight cabin fires in commercial passenger planes. The test evolved into a method that allowed Floyd and I to discover the significance of the *intumescent char* that formed as the foam pyrolyzed.

For larger tests Floyd and I would make trips (mostly in winter) to *Leavenworth* in eastern Washington, to the property of a nuclear customer, where we conducted larger burns using foam filled 55gallon drum test units supported over 150-gallon trays of home heating oil. To hide the smoke- we'd conduct our burns at night in a blind canyon!

Those nocturnal tests confirmed our oil burner results. But man... it was cold in those canyons.

I bought my first computer for home use in late 1976 and learned how to program in integer basic (floating point basic came later). Computers were a godsend, a power tool for my mind. One reason I'd done so poorly in school was because my handwriting was nearly impossible to read, and my spelling- atrocious. Calculators and computers made good crutches for me and as time went by- became my wings. If I couldn't finesse a math problem, I could brute force a solution with a computer- and word processing al-

lowed me to write understandable test plans and reports. It was like being born again! I bought the first one for work in 1980. Roger and I discovered VisiCalc, the first spreadsheet program. About that time, I hooked the company up to Western Union's "Easylink" so we could send and receive telegrams and telexes.

Our first company computer was used much of the time for digitizing and integrating impact (accelerometer) data from our *Transient Recorder*, the numbers crunched in Hewlett Packard Basic. You see- our flexible foam was used for ICBM *Lateral Shock Isolators* on launch tube exteriors and for nuclear weapon and Plutonium Pit storage/transportation containers, for Cruise Missile shipping containers- and other applications requiring our foam to absorb impact energy in specific ways.

Designing the 8000 pound, two story tall, impact test apparatus, assembling the instrumentation, understanding the calculations and programming the computer was the most intellectually exciting and mentally exhausting thing I've ever done... because when I started- I wasn't quite sure how integration worked! More trips to the library.

I built our first network of eight computers (which I named Snow White and the Seven Dwarves) around 1986. Thelma (the office manager) was upset because I named hers "Grumpy". That's about the time I hired Mark- and I've had to beg for IT resources ever since. I bought the first company fax machine about that time.

Later I hooked the company up to the internet which was just becoming available to the public. The internet back then was just text or binary (no pictures). There was usenet, email, ftp, gopher and telnet protocols but there was no World Wide Web.

All commands were in UNIX. There was a “Talk” command that would allow your terminal to connect to another UNIX terminal anywhere on the Internet. Sharon (my daughter) was attending college in New Mexico then, so one day thinking she might be at a terminal I tried to contact her. At work I typed the UNIX talk command and the name of the computer at *New Mexico Tech* followed by Sharon’s username. The monitor screen split horizontally. In the top half I typed “Hi Sharon, Its Dad”. Within a few seconds a surprised Sharon’s answer appeared in the bottom half of my screen. It was absolutely incredible!

As the years went by, I attended technical conferences all over the country, mostly on aircraft fireworthiness, crashworthiness, or on protecting nuclear materials from roadway accidents. I was an ASTM (American Society for Testing and Materials) task group chairman for writing a specification on foam used for structural cores in military equipment shelters- for which I traveled to places like Milledgeville GA, San Diego, New Orleans, San Antonio, San Francisco, and Aberdeen Proving Ground MD. After interminable years it was finally published as ASTM E-1730.

In January 1989 I flew to Sandia National Laboratory to witness a certification burn on a dropped and damaged *Transuranic Package Transporter*, the TRUPACT-II. Note: that *Transuranic* is a nice way of saying... *Plutonium*.

The test unit was supported a meter and a half or so above an 8000-gallon Jet-A fuel fire for 30 minutes. At the time Sharon was still attending college at *New Mexico Tech* in Socorro, about seventy miles South of Albuquerque. So, I rented a car, got us a hotel room, drove down and picked her up and brought her to Sandia. We had dinner, got our passes at the Kirtland

AFB guard shack, and drove out to the burn site. It was dark and the desert test areas (many square miles) poorly lit. It’s not a place to take a wrong turn (you might get shot). We finally found *Coyote Canyon Road* and drove the seven or so dirt miles to the burn site.

It was very dark, but the TRUPACT was brightly floodlit from portable generators. It looked like an alien spaceship that had landed in a dessert swimming pool. Workers in white coveralls were scrambling over the test unit installing thermocouples. It was very eerie and surreal. This must have been the way it looked for the first atomic bomb tests in ‘45 not so many miles south of here.

The next day Sharon and I viewed the 8000 gallon burn along with governor representatives from all the states the TRUPACTS would travel through. There were TV cameras from local stations and lots of press folks. An instrumented aircraft flew through the smoke plume.

After the 8000 gallons of fuel burned off, the red hot TRUPACT kept venting burning foam gases, a process that I expected to cease after 30 minutes or so. (It actually took nearly an hour).

While the gas jetting was at its worst Sharon turned to me and said- loud enough for the Department of Energy representative and Channel-4 news to hear. “Did you forget to put flame retardant in the foam Dad?” Heads turned and there was nervous laughter. I resumed normal breathing only when the flames finally extinguished,

In 1992 a major aerospace customer was concerned that the *delethalizing* foam used in their planes to protect against *headstrike* might be discontinued and I was tasked to come up with a *Delethalization Equivalency Test Plan* for our FP-8000 foam, which we had originally developed for the *lateral shock isolation system* for

Peacekeeper missile basing. To confirm de-lethalization, this customer had originally dropped bowling balls onto the foam and used high speed cameras to determine velocity, energy and rebound.

I thought with our instrumented pendulum apparatus we could do better. We also could compute the *Head Injury Criterion* or (HIC) which was an injury index derived from sled tests on cadavers. The mathematical calculation could cause head injury all by itself, so I asked Sharon to program the thing in *Fortran*. Then I called the FAA experts at the *Civil Aero-Medical Institute* in Oklahoma City who cooperated by supplying us digital data from actual sled tests. We ran that data through Sharon's program, and it was right on! So, I included HIC calculations in the test plan. Boeing DER's (Designated Engineering Representatives) approved the plan and later the FAA came down from Seattle to witness the testing.

In 1994, I was invited by the *Nationals Materials Advisory Board* to attend a workshop at the *National Academy of Sciences* in Washington DC for developing fire safe materials for commercial aircraft. I called the Academy and got them to add Al (our research chemist). We went together. The scientists and engineers came from many countries. It was all very interesting. On the final night we were treated to a formal dinner under the dome in the Great Hall of the National Academy. It was a very memorable evening indeed.

In the 80's and 90's I traveled on business two or three times a year, alone or with Roger or Floyd or Ted.

One trip to Sandia National Laboratory with Roger was particularly enjoyable. We had been working Dr. Ed G. of Sandia National Laboratories on a design for a foam hand grenade,

more properly, the "*MK-141 Diversionary Charge*". It was made from our rigid foam in such a way that it was a "less than lethal" device. It had to be durable enough to be thrown against a concrete wall and remain functional, but when the charge exploded- the case had to turn to dust, producing no fragments that could cause serious injury or death.

We drove our rental car out to Area-5, driving past an arroyo that had a huge wooden trestle built out over it with a B-1 bomber parked on top about five stories above the desert floor. Signs on the barbed wire topped chain link fence said "WARNING ELECTROMAGNETIC PULSE"

We drove carefully past, and after a few more miles turned right onto a dirt road. Finally, we approached a camera topped, remote controlled gate.... and were allowed to enter.

The blockhouse contained lots of neat instruments like highspeed x-ray cameras to photograph explosions. There was a large room with chairs and a lectern. Dr H. of the FBI greeted us, whereupon we all stood up one at a time and introduced ourselves and our organizations.

There were attendees from the FBI, DOE, Delta Force, Navy Seals, Army Rangers, US Marshalls, and other organizations, one- who (to much laughter) just stood up and sat down without saying anything. Everyone was in civilian clothes. Dr. Ed from Sandia then described the device, its dangers and method of employment. We were warned that it would be very serious if one went off near our face or chest... and to be sure to throw it if we wanted to keep our fingers.

Paul from Sandia gave us thick mittens, face masks and ear protection then escorted us outside where we threw as many of the devices as we wanted. Was really cool! There was some concern that a rifle or pistol round would set one off.

So, Ed asked loudly if anyone was packing a pistol- illegal to carry on Sandia National Laboratory which is located on the grounds of Kirtland AFB and so is favored by double security. Hands went inside coats and came out with 9mm Berettas. And yes, that did detonate the MK-141's.

We had a great BBQ lunch at the site (green chili cheeseburgers and all)! Nice people, very polite: yes sir, no sir, thank you and such. They could probably kill you between heartbeats- politely of course. We had a great time.

I hired Sharon in '97 and she's worked at the desk next to mine for 9 years now. It's been a wonderful experience. I've been careful not to show preference and she's had to fight her own battles. Nevertheless, I seem to always be more critical of her performance, like she has to be better than anyone else. I'll be glad to get my daughter back when I retire.

In October of 1999 I was invited by the Jet Propulsion Laboratory (JPL) to attend the *Gossamer Spacecraft Workshop* in Oxnard, CA. They were looking for foam wheels for Mars rovers and for other lightweight spacecraft structures. It was a good conference. I well remember the talk given on spider webs- on their strength, beauty of design, and how it related to super light spacecraft. After the talks there was volleyball on the beach, (NASA scientists vs. engineers).

The banquets were great, but the best parts were at the beach bar where we'd drink beer, look up at the night sky, and talk about space-flight to the stars. Great people: scientists and engineers- wonderful people with wonderful dreams. Later, I'd go out on the beach and walk alone, thinking spacey thoughts... like how very lucky I was.

In October of 2002 I gave a presentation to the *Nuclear Regulatory Commission* at their Rockville Maryland headquarters. Edgy folks though. I got in trouble just taking a photograph of the outside of their building from the street. The presentation went well. It was the first business trip on which Laveta could accompany me. She had always worked before but was now finally retired. We spent the rest of the week on vacation seeing the sights in DC.

I made two trips to the Quantico Marine base in Virginia; both times to attend Homeland Security's "*Force Protection Equipment Demonstrations*". I usually went with others. The first time was to demonstrate our foam/sand blast wall and the second time to demonstrate a briefcase bomb blast mitigation container. The explosions are loud indeed- fun to see (and feel).

After the range is cleared and declared safe, we walk out on the range to examine the remains. It was always interesting to see military and police forces from all over the world.

Finally, at our booth in 2003, I had a delightful conversation with a pretty, snow-cone eating, very pregnant lady with a CIA badge- a "pregnant spook". When I asked if she knew whether it was a boy or girl, she answered playfully "If I told you, I'd have to kill you"... then, smiling, strolled away eating that snow-cone. Now, was that cool or what!

Over the years I'd helped others with papers for publication or presentation at various conferences, but in 2004 I realized that my time was running out. So, I planned to lead-author a paper on using foam for thermal protection in nuclear shipping containers. Zelda and I did the research together and worked up a paper with help from Sevi. It ended up involving a great deal more effort than I'd planned on.

Zelda, Floyd, Glen, Gisela (our translator) Laveta and I traveled to Berlin where I (somewhat nervously) presented it to a large room full of scientists, and engineers at the international *Packaging and Transportation of Radioactive Materials* (PATRAM) conference. Laveta watched from a few rows back. The paper won a Distinguished Presentation Award! It was a fun trip and we found time to discover parts of Berlin.

The Highlight was a catered dinner for invited attendees in the *Deutsches Technikumuseum* hosted by *Areva-Cogema-Transnucléaire*. It was a great venue for a dinner! At the museum entrance, very old bicycles and steam engines were on display. Moving farther along the first locomotives appeared, followed by more modern ones as we neared the dining area. Most interesting of all was Hitler's locomotive, the *Reichbahn*. And in a glass display case alongside the Reichbahn was an unopened bottle of wine... vintage 1940. Tables and chairs, all covered in white linen and were set in a large area bounded by two locomotives. For live entertainment, a stage with a grand piano was set up at one end of the room.

There was a short welcoming address by *Jean-Baptiste des Escotias*, the chairman of *Transnucléaire*, after which many of us I'm sure, ate and drank more than we should have.

At the end of the conference Laveta and I flew on to Italy on vacation.

Much has changed in my 36 years and I've a great deal to be thankful for, in particular- for the creative, productive efforts of my coworkers, including those retired or expired.

The Company family has surmounted many challenges, remained creative, profitable, fiercely independent, and above all- retained its humanity. This culture of honesty, dedication and generosity is worthy enough to embrace (and be embraced by) all its members.

Over the years I've received support, encouragement, understanding and friendship from nearly everyone, but especially from Henry, Roger, Floyd, and Al, relationships that depended on mutual respect for each others expertise but more importantly still, on *mutual trust*. Because you see- we worked together so closely as to reveal our individual weaknesses. It's easy to reveal one's strength to others. Revealing weakness is quite another matter. It requires trust-trust that develops slowly over time in small steps. But- there's real organizational strength in that kind of trust.

This company has been a part of my life, for much of my life and some of those that I leave behind are dear to me. I depart with mixed feelings.

I fully expect to go through some form of postpartum depression before moving along to the next stage of my life. Laveta and our friends have been waiting patiently for me- besides I'm ready to spread my wings.

There's a whole world out there.

clw 7/14/2006

