

## Chapter 4: The College Years

Having taken two quarters of beginning college mathematics at the Denver extension, I applied and was admitted as a full time engineering student. Pat and I moved to Boulder where I could attend classes on the main campus. This was September 65 and CU had just completed a large new complex of engineering buildings. We got apartment on Euclid Ave. and Pat, having quit her position at Southwestern Bell – one of the baby Bells before the AT&T breakup, shortly got a new position at the National Oceanic and Atmospheric Association (NOAA), the national weather organization located in Boulder. I started school in EE. I got a 3-speed bicycle and rode to and around campus for classes. By spring of 66 we got an opening in married student housing and moved to 30<sup>th</sup> Street.

Now 29 years old I had nearly no social interaction with the student body and studied very hard and long hours, and for sure no exposure social fraternities due both to my age and being already married. I often made a Dean's List and was invited and joined scholarship fraternities, Tau Beta Pi ( $\tau, \beta, \pi$ ) and Eta Kappa Nu ( $\epsilon, \kappa, \eta$ ). Two and half years later, with a little help from the Denver courses and continuing study through summers, in spring of 68 I received a BSEE, graduating with High Honors (summa cum laude).

Pat had come to Denver after high school from northern New Mexico. Her parents lived on and her Father, Leo, had a position as head wrangler at the [Philmont Scout Ranch](#). This ranch in northern NM of greater than 200 mi<sup>2</sup> was given by the oil baron Waite Phillips, of Phillips 66, to the Boy Scouts of America. At the time, and still, it hosts more than 10,000 scouts in summer for camping and pack trips. It was a great place that Pat and I visited often during breaks, holidays etc. I often went riding on a Sunday visit with Leo when he was leading scouts on a several hour Sunday afternoon ride. I failed to mention in Chapter 1 that I had a Tennessee Walking Horse (unregistered but we believed so) to ride in the latter years on the farm in Pennsylvania. We also enjoyed great home prepared, by Pat's Mother Rose, Mexican food when visiting as well. Though I was quite busy, we did enjoy the Colorado mountains in a rather passive way. At that stage of life I had not yet taken up backpacking or camping to any extent and neither Pat nor I were skiers. One weekend we visited Estes Park and I hiked with a small group of 4 or 5 led by an acquaintance of Pat to the top of Long's Peak, the highest in Colorado at over 14,000 ft. We did get around to the National Parks of Colorado and the Air Force Academy at Colorado Springs to see the famed cathedral, Cadet Chapel. On one occasion the Brackens, from my past Philadelphia acquaintance, were at a conference in Colorado Springs and invited Pat and I down to the Broadmoor Hotel for dinner.

My work in the Army and industry with flight control and guidance of the Nike missiles gave me an introduction to these technologies. There are many branches or specialties in electrical engineering, e.g. power distribution, radio antenna design, electronic circuit design, and others including feedback control system design. Approaching the senior level in EE, probably due to the Nike and Titan experience, I gravitated to the latter. This was further sharpened when I learned a new graduate professor, Isaac [Horowitz](#), very well known in the controls discipline had been hired, and would be arriving in fall of 68.

Approaching graduation there were many aerospace and electronic technology companies interviewing on campus generously flying graduates around the country for interviews. I interviewed with Goodyear Aerospace in Phoenix, Texas Instruments in Dallas, Hughes Aircraft in Southern California, and AT & T Bell Labs in New Jersey, as well as others. However, I had mostly decided to stay in school for a graduate degree and was pretty much sounding out whether a masters degree in business (MBA) or continuing to a masters

in electrical engineering (MSEE) would be more beneficial to my career. Those guys<sup>1</sup> in the Moses Lake and Tucson bars had gotten to me with the education talk.

I chose to continue for the advanced degree in EE, which I began in the spring of 68. At that time at CU a thesis research project was required for the MS and I was able to get Horowitz as advisor. My topic was application of computers<sup>2</sup> to the design of feedback control laws. In undergrad school I had learned to program Fortran and the research required lots of computer time. In some obscure room the University had an old [Librascope](#), donated by the military and about as big a Volkswagen van, where I often started a program, coded on IBM punched cards, late at night and expected it to run most of the night. I very much enjoyed [Fortran](#) programming and was quite methodical about it usually casting programs for general use rather than just solving the problem of the moment. Many of those programs still exist and are functional today with documentation on the very computer that I am writing now. Although CU operated on a semester basis I was somewhat out of sync. Long 14 to 16 hour days were fairly routine for my studies and continuing through summers, I finished the MSEE in January 1969, about three and a quarter years after arriving in fall 65. After another round of interviews, I accepted a position at a division of North American Aircraft, called Autonetics, in Anaheim, Ca.

Autonetics was essentially the control and navigation systems arm of North America. Among their many projects were the inertial navigation system used by the first nuclear submarine to navigate under the north polar ice cap (an astounding feat in the 1960s), a pea-sized gyro called micron, guidance and navigation for the new ICBM, Minuteman, and numerous tactical missiles and guided bombs. Later North American built the B1 bomber and the Space Shuttle. I was able to make good application of my controls education, mostly working on Minuteman guidance. However, quickly was reminded that to design control systems for physical systems one needed pretty good mathematical models of the system, airplane, missile, instruments like gyros and accelerometers there in, and so on. This had been just grazed in sophomore or junior physics in college so this set off a years long process of becoming more and more skilled at applying math disciplines of geometry, trigonometry, calculus and physics disciplines in modeling the systems to be controlled.

Pat and I rented half a duplex in Anaheim and she was always adept at finding secretarial positions near by, though no specific names come to mind now. She had a Volkswagen Beetle and I had the Pontic still from Tucson as new cars were in the meantime out of the student budget. Far from any relatives or past friends we were mostly making new and drinking in the variety of beaches and entertainment of southern California. Once we drove the Beetle far east into the desert in the hot of summer and on the return outside Riverside the engine overheated and seized up. We had to hitch hike and bus back to Anaheim, returning the same way a week later after repairs.

One day Isaac Horowitz, my CU thesis advisor, came to town and got invited to dinner at our house. He explained that along with his faculty position at the University of Colorado (CU) he had a faculty appointment at the Weizmann Institute in Israel where he spent considerable time. In addition he had multiple Air Force and NASA research contracts that had to be focused at CU. He proposed that I quit my Autonetics job, come back to CU to a

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<sup>1</sup> Some names I can remember from Titan days who encouraged and supported me: Ed Rogers, Walt Kolenkark, Bill Gansert, Vern Roe, Wess Jensen, Galen Nairen.

<sup>2</sup> Masters Thesis: John Smay, [Computer-Aided Design of Second and Third-Order Systems with Parameter Variations and Time Response Constraints](#), University of Colorado, October 1968.

position as Instructor, supervise other grad students in the research, and oh by the way work on my PhD. I don't believe I had ever given 10 seconds thought of getting a PhD. I had by then acquired a friend and mentor at work, Jon Petway, at Autonetics who had a PhD from Georgia Tech. His arguments are long lost but they were rather strongly in favor. So by summer of 1970 I was resigning Autonetics, and loading up a U-Haul truck at Canfield Lane in Anaheim with generous physical help from Jon. Meantime I had contacted one of the few friends acquired while undergrad at CU, Lew Frauenfelder, who helped out by miraculously renting us a house in Boulder belonging to a chemistry professor. Pat and I set out with the U-Haul containing the total of our belongings and towing the Pontiac behind. Though I don't recall details, we must have sold the Beetle. My previous major moves to the northwest, southwest, Denver, California had all been financed by generous company travel allowances with moving companies and temporary hotels along the way and while settling in at the destination. This time it was all on me and much more frugal.

Most of the CU EE faculty were familiar as I had been gone only a year. I first taught electrical circuit analysis, a freshman, sophomore sequence of two courses. After the first year I taught graduate level feedback control analysis from the Horowitz book, *Synthesis of Feedback Systems*. This text was very thorough if you studied it long enough, but was not friendly reading – I can't remember anyone who actually thought well of the book's presentation, though it's content was well respected. I made copious hand-out notes that my simple mind could digest and shared them in classes with the students.

Most readers will not relate, but the discipline of feedback control was in a two decade turmoil of purported transition from *classical techniques* (frequency domain) to *modern control* (time domain) and Horowitz was a strong defender of the former. NASA set up a Flight Control Design Challenge for the flight control system for a high-performance jet fighter airplane. Separate researchers were to choose a technique, come up with a design and compete. Somewhat by default as Horowitz's PhD student, I got the classical design assignment. After working a year the competitors had a face-off at a technical conference at Washington University at St. Louis. I recall only one competitor on each side, each declaring victory. My design was largely control parameter scheduling based on various flight control sensors such as altitude, pressure, temperature, Mach number and such. It was pretty much 'classical,' ultimately not qualifying as PhD research and resulting in loss of a year in my PhD progress<sup>1</sup>. I kept on teaching and chose another project and a year or so later succeeded in qualifying for the PhD<sup>2</sup>.

In early 73 another round of interviews at companies having use for feedback control technologies. I had interviewed at IBM, who now had a large computer storage development and manufacturing facility nearby in Longmont, Co., at Hughes Aircraft Radar Division in Fullerton Ca., and Honeywell in Phoenix. Another PhD student that I had met, Bob Weakley, passed in the hall one day and the conversation included his mention of having interviewed at Hughes Space & Communications Division where a past Berkley classmate of his, Fred Van Kirk, worked. I had only been minimally aware of this Hughes division somehow, despite having traveled to interview twice to the Fullerton division. The spacecraft work and coastal

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<sup>1</sup> In the writer's opinion the frequency and time domain techniques eventually settled into the niches where they worked well, no longer competing: Frequency in feedback control of physical systems like aircraft, missiles, etc. and Time in filtering and such as navigation, system identification and modeling.

<sup>2</sup> PhD Thesis: [Synthesis of Oscillating Adaptive Systems](#), John Smay, University of Colorado, Boulder, Colorado, June 1, 1973.

location that Bob described sounded great to me and I immediately set about getting an interview there. The rest is history for another chapter, including the life long friendship with Bob and Fred. After the interview trip to El Segundo, Ca. there was no question where I wanted to work so after cleaning up some academic and personal details Pat and I were headed to Southern California again in late spring. It happened that Bob did not go to Hughes, but instead accepted a position at Air Research in Torrance, Ca. in the same neighborhood where Pat and I would settle, and consequently leading to life long close friendship.

One of the personal details was a long visit to Mexico. It happened that my sister Barbara and spouse Mern were living in El Paso and regularly making day trips across to border to Juárez, Mexico. With Pat's Hispanic roots and language skills and the affinity of all our local visits to Mexico, the idea of a deeper trip began to brew months earlier. I had been in contact with a travel agency in Texas with expertise in train trips in Mexico. We set up a long train tour.

### *Mexico and Copper Canyon*

The trip was at once wonderful and a disaster. We boarded the train on a hot spring late afternoon in Juárez bound 225 miles south to Chihuahua. The train had no ventilation except open windows with blowing sand, passengers with squawking chickens, and the train sometimes slowed by plowing a 6 inch drift of sand from the tracks. Upon arrival in Chihuahua our hotel didn't recognize us or our reservation, but were helpful in securing another room several blocks away. Struggling through the dark street with luggage, no rollers bags in 73, we found the lodging and crashed for the night. Next morning we got on the second train bound west for Los Mochis, then Culiácan, descending to Sea of Cortez (Gulf of California) through the scenic [Copper Canyon](#). The descent through the [canyon](#) is indeed spectacular and famous with 39 bridges and 87 tunnels. Sometimes the train would stop for half hour with front section in a tunnel and rear portion not yet having entered the tunnel, perched on a cliff side track, to repair the brakes or some such. Maybe at times we could see the front of the train emerging from a tunnel below on the mountain while we were entering above<sup>1</sup>. My best recollection is that we were 12 – 14 hours on the train, enough time to be sick from the food, and arriving late night at a hotel in Culiácan. After a good breakfast we moved on south to Mazatlán where we stayed for several days. Neither Mern nor I, were swimmers and on one occasion both drifted out with rising tide until suddenly there was no bottom. Fortunately someone on a surfboard was close enough to hear and assist. On a day trip into the gulf for game fishing a very large marlin, (200 lb ?) was caught and wrestled to the boat over 30 – 45 minutes, mostly by Mern and boat crew though everyone got a little action. On shore it was hung up, weighed, pictured, and destined for an orphanage, as the Mexican public at the time didn't consider marlin desirable enough for eating – today it's \$12/lb at Safeway when you can get it.

From Mazatlán we continued south by bus, another exciting ride, to a location to catch another train to Guadalajara, perhaps at Tepic. Then a very scenic train ride and more bad food through Guadalajara to Mexico City. In Mexico City for several days we explored museums, parks, pyramids. The final train ride of more than 24 hours from Mexico City to Juárez was an endurance of more sick bowels and average Mexican countryside scenery. In

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<sup>1</sup> [El Lazo](#). Beginning a sharp descent this area is called "The Loop" because at this point the railroad makes a complete circle and crosses over itself.

general we were able to find good Mexican food when off the train, and unfailingly got sick when we had to eat on the train. This was my first trip other than cross-border day trips out of the US. Mern had been stationed with the Army in Germany and they had explored some of Europe.

Upon return to Boulder Pat and I supervised the mover pack up and headed to my new engineering job at Hughes, getting an apartment in Torrance, Ca. for the first few months, then purchasing a home close by in Torrance.