MY LONG AND SATISFYING CAREER AT HEWLETT-PACKARD

Alan Bagley

Foreword

Mr. F&T, "Bags"

In any long-term human endeavor, whether an organization, company, program or project, legends develop. It might be an historical event that grows in significance with time, to become legendary. It might be legendary people; at HP we knew our legends by their first names, Bill and Dave, and of course, the irascible, IQ = 180, Barney. We had the flamboyant "Uncle Miltie" Liebhaber at HPA, and the voluble Paul Ely. And then there was the taciturn Alan Stevenson Bagley, "Bags." The author of this charming HP Memory.

At HP there were some legendary products too, one of Al's best known creations was the HP 524A-series electronic counter, arguably our heaviest product. It was said that Packard joked that it needed to be shipped with a hernia belt, to avoid hurting oneself lifting it. I can attest to that. On the 1952 Operation Ivy, atomic test operations at Eniwetok, on D-2, two days before the fusion bomb shot, two of us young engineers boarded a military helicopter with a 524A to check the remote time base generators at about 6 instrument bunkers stretched along the blast line for 20 miles from ground zero. At each location we lugged that counter through the sand to calibrate the shelter.

Al's Frequency & Time Division had an amazing string of innovative products, from the Flying Clock Cesium frequency standard which drives our global time references, to the dual-frequency laser dimensional instruments which could measure a microinch and less. His division leadership provided HP with our first semiconductor process operation under Ed Hilton, which supplied unique functional integrated circuits. And he did it on the cheap. Quality yet inexpensive. Another example of my own, in my LED digital number production line of 1969, we used Al's special Santa Clara bi-polar decoder/driver for the 4 x 7 matrix of LED numerals, and others.

Al's creativity led to an amazing diversity of projects and installations across his labs. Since quartz crystal components were the heart of his counter products time bases, he installed a quartz production lab to exploit their finest performance. Those quartz crystals were adapted to read precise temperatures and to log extreme pressures down inside oil well exploration. His digital recorders were one of the first examples of data logging by capturing the counter readouts on paper tape records. Later, his labs were instrumental in the creation of the revolutionary HP-Interface Bus which linked instrument control and data acquisition to computers.

Digital technology naturally flowed to his F&T Division. When two aerospace company engineers approached HP with what appeared to be a revolutionary idea to improve calculators, Al's top digital experts pronounced the innovation feasible. This led to HP's dominating position in scientific calculators, the 9100A and HP-35 electronic sliderule, and a lasting dynasty in technical consumer products. As the US Defense Dept rolled out its Global Positioning Satellite cluster for military navigation purposes, his visionary Charlie Trimble built a GPS receiver team to exploit the technology. Had it not been for Hewlett's decision to not enter that non-instrument field, HP would have been the leader in that business. As it was, Trimble left with HP's blessing and built a thriving company, and a leader in GPS navigation to this day.

In my mind, the word serendipity has always been connected with the name Frank Boff. A diode was exhibiting strange behavior which Frank linked to an article he had just read. He realized that under certain conditions that diode was not a non-linear resistor but a non-linear capacitor. The resulting "Boff" diode became the ubiquitous "step-recovery diode" component which revolutionized RF and microwave instruments forever. It was able to switch tens of volts or hundreds of milliamperes in less than a nanosecond. The result was the ability to generate milliwatts of harmonic power at 10 GHz from stable oscillators running at 200 MHz. Truly a wonder element.

His personal style is wry (and dry) humor, sometimes irreverent. And noticeably shy. For example, in all the years I have known Al, since 1958, he has never mentioned that he was a B-29 pilot in WWII. I daresay that very few others at HP knew of his military service either, although that is clearly the way many veterans handled their memories of service. This HP Memoir was adapted from a detailed timeline of Al's life and HP career, prepared by his Son-in-Law. You will find it an interesting read; how a young man from a remote desert crossroad "town" named 29 Palms, got accepted by two of our nation's most prestigious technical universities, Cal Tech and Stanford, and then built a remarkable personal career in those Golden Years of High Tech at HP.

-- John Minck

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Introduction

I was born in Pasadena, CA, on January 8, 1924, the second son of a banker from Walla Walla, WA, who had joined the Army Air Corps in WWI. His unit was marshalling at West Point, NY, to be sent to Europe when that war ended. In 1922, to get back to the West, he and my mother and baby John moved to Pasadena, CA. He continued in banking, but developed severe asthma. In 1927, his Pasadena Doctor James Luckie, recommended a trial month in a high, dry Mojave Desert area he had researched as beneficial for victims of asthma and WWI gas attacks. Dad bunked at friend Ben Benioff's desert cabin for a while that spring. At the advent of cooler fall weather Mom, John, myself and newborn Dennis joined my Dad, who was much improved, in the remote, dramatic Mojave landscape at Twenty-nine (29) Palms near the Oasis of Mara. They homesteaded 160 acres. Our family made its home in a two car garage, which eventually also housed our business, a general store.

My Boyhood in the Mojave Desert

Mom (who was Helen Goltra of Portland,OR), and Dad (whose mother’s name was Stevenson) helped pioneer the community as the primary drivers on many projects, such as the creation of an elementary school, surveying homestead boundaries and paving main roads. We Bagley boys lived a free roaming desert life. I learned to cope with the dangers of black widows while cleaning the out-house, scorpion bites and stepping on rattle snakes.

Like most young boys in the depression, we found plenty of things to do with our time. I remember being engaged with technical things. I recall my teacher, Mr. Kessler, taught our class Morse code and helped us students build a telegraph. I had bought a $4.95 "Learn Electricity" mail order kit to build two telephones. My school pals strung wires from the Bagley store to a cave we had dug on our property. The kit's hand-cranked magneto later served to power an "electric chair." Our rule was each boy could only mete out his own sentence.

Another experiment in my electricity kit was the "welding" lesson. Using house power I could to melt nails together, although my Dad soon discovered why the lights were intermittently dimming. In yet another experiment, I found that a tiny internal combustion airplane engine I had would not produce enough compression to power my toy car. Looking back now I wonder what I was thinking to mix copper and cyanide in my bedroom to attempt to copper plate the engine's piston. It didn't work. So I took it to Tom Martin, my best friend Troy's dad, who was the area's mechanic at Tom’s Garage. He showed me how to build a piston ring from a watch spring and create good compression.

My Mom reminded me later in life of my “sensitive, quiet and spiritually-attuned nature,” when following my radio heroes. She noted that I talked 5 of my friends into eating enough Ralston cereal, until we had enough labels to get an embossed charter for the 29 Palms Chapter of the “Square Shooters Club.” My Dad, often overworked, impatient and stern, took time to “officially deed” five acres to the club house shack we built on the land. I’m not sure if this was my early try at management and organizing, but it probably didn’t hurt my later HP days.

My introduction to radio technology was a bit strange. Area miners would come to town and hit Jay's Bar on Saturday night. Awaking on Sunday morning, the miners would remember their need for supplies and come pounding on the Bagley's store/home door pleading for service. But Sundays were picnic days for our family, out in the desert, and among the Joshua trees and boulders. The miners' demands were an unwelcome interruption, so my Dad asked me to make a two-way radio to communicate between the store and the desert picnics. I worked with a new arrival, Jim Page, who knew amateur radio. Page helped me build a radio. Just as the radios were set to solve the problem a new solution was worked out and they were never installed. But my imagination was captured by this new technology

In 1937, I graduated with the second best grades and as salutatorian of my grade school class. That fall, we entered the 29 Palms High School, initially held in a surplus American Legion shack promoted by my mother shortly before brother John had come to high school age. By the time I entered the school it even had a little lab room with chemical reagents for the study of chemical symbols. I’m afraid my tendency to mischief got the best of me and my friends, who labeled a new bottle "PIS^2," filled it with urine and put it on the shelf. Discovered by the teacher, she said, "I recognized both the odor and your hand writing, Alan Bagley."

In high school, I also discovered that I had an aptitude for music. Ted Hayes, an actor turned teacher, came to be the principal at the high school. His wife, Mary taught music, a topic that engaged me, further developing my musical aptitude. This interest continued throughout high school. I joined and studied with the prestigious All Southern California Symphony Band, which performed concerts in Pomona annually. I was significantly influenced by the Band's principal teacher, Herbert Grey. By the time a college major decision was to be made, I was hard pressed to choose between music or science or engineering.

Getting out of 29 Palms

To satisfy a strong interest in studying physics, not offered at the 29 Palms High School, with my Mom and Dad, I decided to attend my senior year at the Riverside High School in the L.A. basin. I joined my older brother John and his friend Stan, who were living in a small house behind the baroque Riverside Mission Inn. In a high school class I helped build an early version of a television using a spinning disk with a photo cell behind it. Not being able to afford both a sending and a receiving apparatus for our TV project, my high school team arranged for both sending and receiving to be synchronized on the same shaft.

In 1941, I had a decision to make about college: Redlands College to study music or California Institute of Technology to study science or engineering. But first, I spent a year at Pasadena Junior College to get my grades up, especially in chemistry. In this early war year of 1942, Japanese submarines had threatened a West Coast attack and a blackout was in effect in Pasadena.

The WWII Army Air Corps and Me

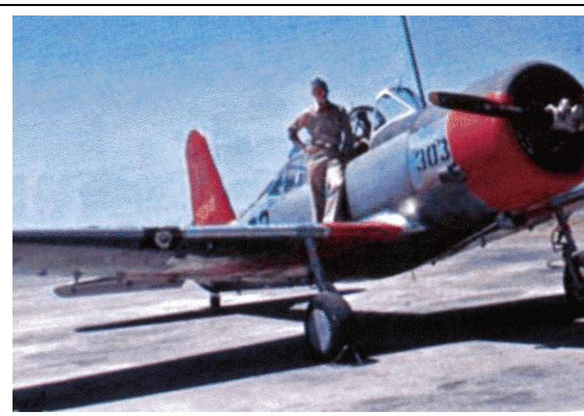
When I managed to pass a tough one-and-half day exam to qualify at Cal Tech, I decided that was the school I should enter. But by March of my freshman year, our class was being pressured to join the Armed Services. Recruiters were on campus promoting, "Avoid the draft, become a reservist, stay in school." I promptly enlisted in the Army Reserve.

I was called to Fort MacArthur in Long Beach, CA, and was barracked with Americans I had not experienced much of before, including African Americans. During a gas mask response to an anticipated attack, our troop was herded underground only to hear the citizens of Long Beach standing about above discussing the racial situation. I was appalled because the blatant bigotry just didn't seem right, although all my life experience in the desert, so far had not exposed me to this dark side of human relations.


Headed for the Army Air Corps

My brother John had joined the Army Air Corp. He urged me to join that Army branch as well, much as our Dad had done during WWI. Just before being transferred to the infantry I was accepted into the Air Corps. Before the war the Air Corps had been reserved exclusively for college men. Now, with war underway, the Air Corp provided special training. I was sent to Pullman, WA for classes such as navigation. I then joined brother John at the training station in Santa Ana, CA. The Corps ran tests to give results which would place me as a pilot, a navigator or bombardier. Piloting appealed to me most, having learned to do trigonometry in my head, I was able to "game" the Air Corps tests to get the outcome I wanted, which was pilot training.

Pilot's training was next, at Thunderbird Airbase in Scottsdale, AZ. Here I met the metal monoplane dubbed the Basic Training 13 or BT13. Unfortunately, I suffered a bout of pneumonia from the training's routine exercise sessions in the cold, damp early morning air. Due to my time in sick bay, I missed being sent to the airbase near 29 Palms. Instead I was sent to the Lemoore Airbase south of Fresno for six weeks where we trainees were taught by private pilots. We learned the concept of the "iron compass," that is following the railroad tracks on the ground to determine your route. Along with this came the pitiful fun of terrorizing sheep herders by diving your plane and scattering their flocks.

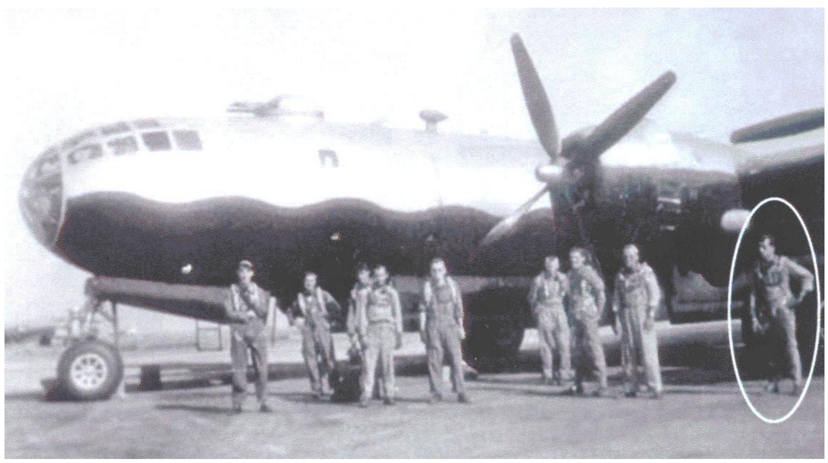


These were pretty heady times for a 19 year old.

In 1943, I again joined my brother John at Williams Air Force Base near Chandler, AZ. It surprised me that we were able to "arrange" to be serving at the same locations. Here the training was in the hot, acrobatic AT6 aircraft. We were taught to lead our targets using skeet shooting as an example. It was good to be with John again. Sent up with an uneven number of planes to practice a 'V' formation, John swung his plane from side to side in the 'V,' determined to "even things up," until he was told to "Cut it out, Bagley!" Then John was shipped out to fly B25 bombers targeting Japanese bases on Borneo.

I went on with training in Hobbs, NM. John and I, anticipating military censorship, had devised a code to be used in letters home to identify where we were stationed. It consisted of secreting your longitude and latitude in the number of words in the first and second, etc. sentences of a letter. It worked. John reported he was bored in the Pacific.

Then I became a test pilot for the re-engineered B17 bomber, getting my required 250 hours flight time. I next volunteered for a secret project in Victorville, CA, training pilots to operate radar and the new Norton bomb sight. Emulating John's previous buzzing of the Bagley home in 29 Palms, I set out to let loose a roll of toilet paper when my flight plans took me over home. I missed, 10 miles to the east. After the war, recounting the story at a party in 29 Palms, a woman exclaimed, "That was you! It took me a week to get that toilet paper out of the greasewood."



Before the end of the war, I trained to pilot the B-29 bomber, me at far right.

I got orders to move to Alamogordo, NM to take training in the new B-29. One crew rode in the back while one took the controls. Soon those at the controls were playing practical jokes on the crew in back, rolling them around or tossing them through the tunnel that traversed the bomb bay.

By 1945, to hide the goings on at the 'A' bomb test at White Sands, NM my unit was given "access to secret inside information" - there was said to be a site nearby for storage of captured German V2 rockets. When our unit saw a brilliant flash during a 5:30 AM flight on July 16, 1945, we knew those V2 rockets had somehow been detonated. The public was told the explosion was an accident at an ammo dump, but my unit "knew better." The end of war was, in one sense, a disappointment, all that training for nothing. The senior airmen mustered out first leaving no one to operate the mustering out process. Our unit had to fly to March AFB in Riverside, CA to muster ourselves out of the service.

I returned to a shack on the Watson place in 29 Palms where I taught myself calculus in preparation for testing back into Cal Tech as a sophomore. The GI Bill was a tremendous help in financing my time at Cal Tech. My parents bought a little house I moved to in Pasadena. A high academic level was being set at Cal Tech by the likes of professors Robert Millikan and Linus Pauling, both Nobel Prize winners. At that time, I thought I wanted to major in geology, based on my experience in the desert, I liked working out of doors. But my chemistry grades were not good enough. So I started on a major in civil engineering.

How the Names Hewlett and Packard Entered my Life

I first heard of the company in 1937. I was then a senior in EE at Caltech, and my wife and I were visiting her sister and her husband in San Carlos, CA. He was Nicholas Boratynski, an Electrical Engineering graduate from Cal. During the visit, Nicholas asked me if I had any ideas of where I wanted to work when I graduated, and I said I didn't. "Well," he said, "let's approach the problem logically. Do you want to join a big company, or a small one?" Having been unimpressed with interviews at a couple of larger companies at that time, I answered "A smaller one." "OK," he said. "I have met a couple of guys in the San Francisco Engineers Club who are starting a company, and I think they should do well. Their names are Hewlett and Packard, and they make electronic measuring instruments." That didn't sound very exciting to me, so I said "Will they try anything new?" "They sure will," he said. "They are also making electronic lettuce picking equipment. It fits on a tractor and scans the ground with electric eyes to select the plants that look worth picking." Nicholas described the apparatus in some detail, and it was interesting enough that when we returned to Pasadena, I still remembered the names Hewlett and Packard.

Back at school, when I happened to see an article in the IRE Proceedings that described an interesting breakthrough in electronic amplifiers, I noticed that it was authored by "Hewlett, et al." The article stated that to maximize the gain of the device, it should be made up of a few stages, each with a gain of e, (2.76…). Having learned about that scientific constant in a mathematics course, I was impressed. Not only were these guys innovative enough to design a lettuce picker, they were acquainted with science. I called Nicholas and asked for their address. He said I could probably find an advertisement in the back of the Radio Amateurs Handbook, and I did. A very small ad gave their address as 30410 Page Mill Road, Palo Alto. I sent my letter of application to that address, and in a few days received a nice note from Mr. Hewlett saying that they appreciated my interest but were not hiring new engineers just then. I wrote down that address anyway.

During the summer after my junior year, I had tried to make an oscilloscope out of a surplus radar set, and found that the theory of electronics I was learning was nowhere near enough to make me a useful electronic engineer. That experience, together with the advice that another year of school would be useful, caused me to look for a master's degree. I knew the importance of the fundamental science I was learning at Caltech, but decided to visit Stanford to see what they offered.

When I saw that they were giving lab courses that utilized the very latest electronic measuring equipment, such as Tektronix Synchroscopes, I was impressed. Then, on a lab bulletin board, I saw that Hewlett-Packard was offering some sort of fellowship that included financial aid. I told Stanford's Joe Pettit that I was very interested in that, and would come to Stanford for my master's degree if I could get that fellowship. He told me that my C+ average at Caltech was equivalent to a B+ at Stanford, so I could probably get some sort of scholarship. When I said that the HP Fellowship was the only one I was interested in, he said he would see what he could do.

I Transfer to Stanford

A couple of days later he informed me that I and another student named Quentin McKenna would share the HP Fellowship, and that we would meet H and P at a lunch to see what would be involved. When we met them, they chatted with us for a short time, then asked if we had any ideas or inventions we would like to work on. We both said we didn't, so they invited us to another lunch where they might have an idea of something we could work on.

When we met again this was their plan: In the first quarter, we should go to the library and study the Nuclear Physics industry to see if there was something they wanted to measure that might be done with some electronic gear. In the second quarter, we would dream up some new equipment that might make such a measurement. In the last quarter we could try to make such a piece of equipment, and actually visit the HP lab to do that. In other words, study the market, find their need, and fix it.

So we did. In the first quarter, we found that radioactive sources had become too hot for any Geiger counter to accurately measure. Such devices would see two active pulses closer together than about 10 microseconds as only one pulse, while the new scintillation detectors were emitting millions of pulses per second. So, I proposed to find some electronic means of properly detecting and counting pulses much closer together than a microsecond, and Quentin proposed to make a high-speed double pulse generator to accurately test such devices.

At that time we were both learning enough in the EE Lab course to put a few useful pulse circuits together, and we decided to take Dave and Bill up on their offer, so we did go out to the HP laboratory to work on our ideas in our last quarter. H & P had arranged a work space for us in the Quonset hut where the engineering group was located. I lived in a garage in Woodside, during this time, but Ibby and the girls had stayed behind for a time in 29 Palms.

So, there we were - a couple of students working along with regular professional engineers, (there were about seven of them at the time), who were very helpful in letting us borrow tools and parts as part of our Stanford fellowship. They knew it was just another generous arrangement typical of their bosses. Our devices made some progress in that final quarter, and we were so impressed with the company that we both applied for employment. They had room for only one, and I got the job. My pulse counter ended up in the HP catalog, and my very fortunate career was started with the best company that ever existed. It was called HP.

Hewlett-Packard Full Time

In 1949, as my Stanford Masters program was ending, I applied for a job at HP and got the only one offered to Stanford grads. HP had 130 employees and just over $2 million in sales. I thought I was pretty lucky to be offered $250 a month.

HP 520A High Speed Decimal Scaler, circa 1950

Once at HP full time, Dave Packard directed me to continue the work he had begun during the fellowship. Hewlett suggested I widen my thinking to faster counters. At that time, most electronic counters would only handle frequencies up to 100 kHz. But one of the industrial applications I studied at Stanford was the emerging nuclear energy research going on. One of the functions that researchers wanted to measure accurately was the count rate of atomic particles hitting a detector, resulting in an electrical pulse.

HP 520A Frequency Scaler

We decided to set the counting rate specification at an equivalent of 10 MHz. But since the nuclear pulse events are aperiodic, the first stage required the ability to handle equivalent pulse repetitions of up to 10 MHz. My solution was to create a 100 to 1 divider which could input 10 MHz signals such as pulse events of nuclear radiation, and output a signal 100x lower. This reduced signal then fed into a standard counter. It led to the first product called a HP 520A High Speed Decimal Scaler.

HP 524A/B Electronic Counter, circa 1950

The HP 524A, an HP Legend

After the 10 MHz scaler, with some further thinking, it began to be clear that we should add in a time base and develop a true electronic counter, which read pulses per second, or frequency. This was my most important product and the one most closely associated with me over the years. In addition to measuring frequency in MHz, etc, we included some circuitry which converted the counter to count its own time base signal, with the count being turned on by an outside signal, creating a time interval count. The interval was the time between the external on and off pulse. It could measure intervals of time with an accuracy of one part in ten million. At the time I created the 524A, it was the most expensive HP product at $2,000, the most power consuming, and the heaviest. It normally took two men to move it. At one point I was obliged to set up a demonstration on the second story of a building at Stanford, and I struggled with the weight. Packard used to joke, "An accessory to the HP524 should be a hernia belt."

The HP 524A Frequency Counter

Out of this product came the entire line of HP's high speed frequency model 500 series counters. I take a lot of pride in all those counters because in a real sense, they were my first product development as a brand new HP engineer. And they performed well against the major competition of the time.

Promoted to Group Leader, 1952

By 1952, I was blessed with some early successes on products and was promoted to Group Leader in the Development Laboratory. My salary had nearly doubled to $475 a month. I was working 80 hour weeks on a regular basis. I later observed, "This makes for a poor family man," But I did find time in my few off hours to roof and wire a new house to save building costs. Late one evening I slipped into the HP shop to attempt to reinforce what were flimsy home electrical boxes. "What are you doing there?" It was Packard passing through late. He stayed and helped me with the home project.

The Start of the Yet-to-be-Named "Silicon Valley," 1952-1957

In 1952, HP's letterhead positioned the firm as "Laboratory Instruments for Speed and Accuracy."
My team of engineers was at the center of HP's strategy and HP was an industrial rocket. Income alone had reached $11 million, over five times its sales in 1949. My team's second counter measured both frequency and time, expanding the product line's concept as Hewlett had recommended.

I was asked to give the first talk to the newly established San Francisco Peninsula subsection of the Institute of Radio Engineers, as the field was then generally known. The talk included a demonstration of the 524A high speed digital frequency counter. The 1951 establishment of this chapter of the IRE was another marker in the beginning of what would come to be known as the "Silicon Valley."

My management responsibilities continued to increase, from Manager, R&D of the "Counter Lab," to Manager of the whole Frequency and Time Engineering Department. We invented a range of advanced frequency and time measurement devices, some of which will be described later. These included, as examples, heterodyne converters, transfer oscillators, time interval meters, rate meters, precision delay generators and a digital recorder - in all, over time, earning billions of dollars for the Firm. One big help was that Bill Hewlett still had contacts in the Defense Department, from his military service in the Pentagon during WWII. With his help our team closed a big sale with the Army Signal Corps.

Promotion to F&T Division General Manager, 1961

In 1960 David Packard asked me to consider, "Do you want to stay focused on engineering exclusively or move more into management? Give me your answer in 12 months." I made my decision and told Dave, and in a year I took the role of General Manager of the Frequency and Time (F& T) Division. In 1957, HP had decided to move from a partnership status to became a public corporation in 1957. HP was listed on the NYSE in 1961.

Meantime, I was working hard to develop a top flight team with Dan Lansdon as my R&D manager, and a brilliant PhD by the name of Len Cutler. The new division, one of four at the time, had considerable independence. The Division had departments of engineering and manufacturing, but I felt that we were missing a better coherence with our field force and customers by not having our own division marketing and finance departments. I worked to get this approved and it was.

Eventually each Division was given its own profit and loss accountability. F&T became the highest grossing, most profitable division in the company. In 1962, HP reached Fortune's list of the top U.S. companies with 6,260 employees and $110 million in annual sales. Friendly competition between the HP Divisions was spirited. But it was not long before the Microwave Division passed F&T in sales revenue.

The HP 5100A Frequency Synthesizer, circa 1963

Our division’s product strategies focused on highly accurate frequency counting and in the opposite sense, the generation of precise frequencies. One of our most important products to provide the generation niche was the HP 5100A Frequency Synthesizer. Our division was able to overcome a range of complicated technical problems to create the first programmable frequency synthesizer, with a frequency range of 0 – 50 MHz. It featured extremely fine tuning, and ultra fast switching speeds, making it ideal for some advanced digital communications called frequency-hopping. It was developed in secret within HP, and was based on a classified patent that our team was able to convince the U.S. Navy to license to HP. it was able to do the work of a whole battery of instruments and was eventually used to support communications with deep space vehicles.

5105A Frequency Synthesizer, this model to 500MHz.

At about this time I teamed up with John Young, the General Manager of the Microwave Division, to press HP Corporate for the Divisions to have closer links between the factory and the field. The result was the creation of a new layer, three HP "Product Groups." F& T was in the Electronics Measurement Group and John Young was tapped to head it, and became my boss.

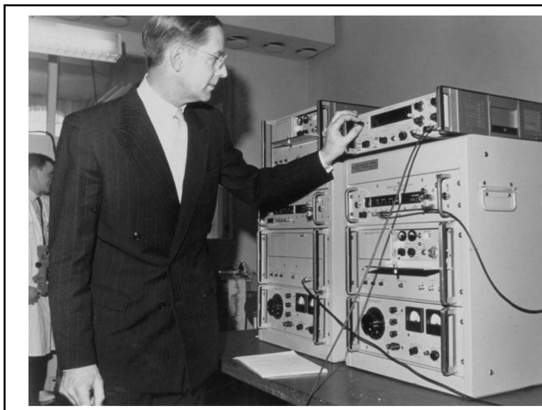
“Our Finest Hour,” the Cesium Atomic Clock, circa 1964

That’s a takeoff on the Winston Churchill WWII pronouncement, but the technology which led HP to dominate the world of time keeping was based on our best product to that time, literally our finest and most accurate hour. By using the atomic resonance of the element Cesium, we created a time standard based on atomic physics, and not the resonance of a quartz crystal. This product was also in line with our stated product and business strategy of providing extremely precise RF signals.

5060A Cesium Beam Standard

Using this standard "Atomic Clock," our promotional department created a well-publicized world tour, which was dubbed the “Flying Clock.” The chair-sized instrument usually occupied a first class airline seat, with standby power supplied from the baby bottle warmer outlet in the galley. The idea was to visit global standards labs including our U.S. National Standard at the U.S. Naval Observatory in Washington, D.C. Then further comparisons were made at Swiss Observatory in Neuchatel. The clock was designed to maintain accuracy for 3000 years within only one second of error, a truly remarkable leap ahead for time keeping. Just in time for the Apollo Moon mission which required precise timing to carry out the critical navigation and communications.

The HP line of Cesium standards came to completely dominate the standards world, with most large and aerospace companies buying their own resident standard. And for decades, as the communications technology moved to digital formats, the transmitters and receivers were required to be synchronized to a very precise scale. This has become even more critical as the technology moved to fiber optics which exploit data rates in the 10 giga-bit region and higher.



This system shows a typical primary standard system clock with backup power and comparison instruments.

As manager of the product line, I naturally joined the traveling road shows, and enjoyed the customer interaction. While on one of the European legs of these travels, I made a point of looking up a woman living in Geneva who I had met at HP, whose name was Lorna Munn, who later became my wife of many decades.

The Contributions of Charlie Trimble, Hired circa 1965

In the mid-1960s we hired Charlie Trimble out of Cal Tech to eventually become the division's Manager of Integrated Circuit Research and Development. When HP decided not to go into the global positioning system (GPS) business, Charlie bought the technology for $50,000. I became a founding investor. Later Charlie created a Scientific Advisory Board for Trimble Navigation and asked me, Len Cutler, and Brad Parkinson to sit on it. I thought it was a smart way, in part, to pull friend Brad into a relationship with Trimble. Brad had been head of development for the U.S. military’s use of GPS.

Our Venture into Integrated Circuits, circa 1967

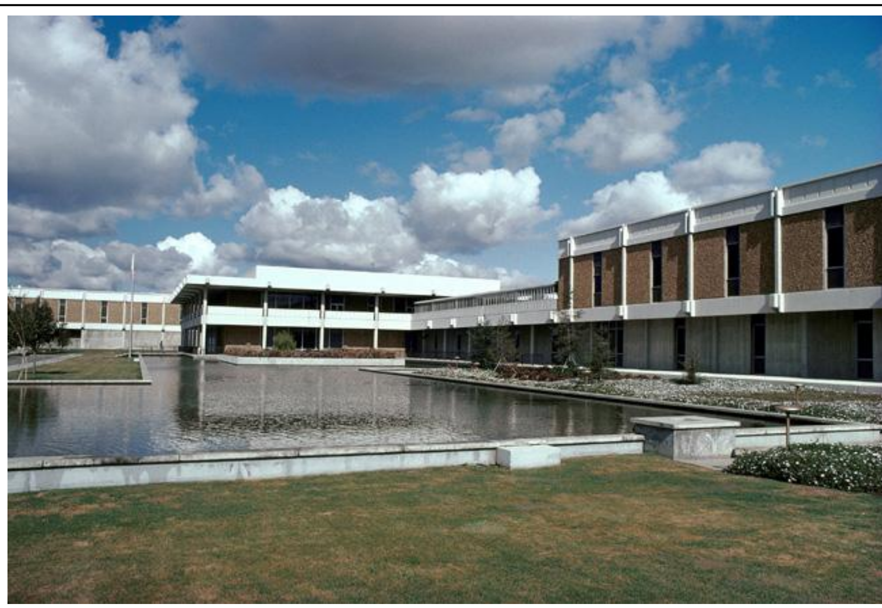
It all seems so obvious in looking back, integrated circuit technology of the mid-1960s was going to dominate the world. But at the time, the talk was mostly proclamations and vision, and big questions on the massive investments needed. I attended a U.S. Navy technical seminar on the new concept of integrated circuitry. Texas Instruments and Fairchild both predicted great things for their "monolithic" approach to ICs. Three of my engineers went to a Motorola course to size up these new ideas. Was it black magic or the next big thing? The course was part of Motorola's sales pitch on ICs. At F&T, we found a former Motorola man who taught my team in depth the chemical and physical processes of how to make IC's themselves.

I assigned five engineers to further study ICs. They read everything available, gleaning information from Philco, Stanford, and Hughes. From CBS Hytron, we hired Max Shuller, and I teamed him with Ed Hilton, who was taking on the difficult job of building our processing facility. With this team in place I then proposed to David Packard that the hundreds of thousands of decade scalers HP was then using in our counter line, could be replicated on a few thousand IC chips. Demonstrating HP's famous "can do" attitude, Ed Hilton's team was soon running our company’s first integrated circuit fabrication plant for a modest investment of $250,000.

When Packard saw the integrated circuit machinery going into place smoothly, it fell on me to convince him that it would be economical to make "these tiny little things." By the time our crew had ICs up and running Packard had done enough reading to understand that "small was economical." Our division had become the first home of "things digital" at HP. The new ICs were used to make HP's frequency measurement counters much cheaper, more reliable, smaller and faster.

New F& T Division Headquarters Behind "Lake Bagley"

HP's practice was to cleave off divisions when groups reached about 1,500 people. The purpose was to maintain divisions as "agile" businesses, able to take decisions and actions nimbly. My division was asked to relocate F& T from Palo Alto. The criteria were to locate within one hour of a major airport and a major university. San Diego, Pasadena and Santa Cruz were identified. The most distant, San Diego, was F&T's favorite. HP, however, had previous experience with major moves, and had lost nearly a year's production moving the Scope Division to Colorado Springs, which was HP's second re- location outside of Palo Alto. At a meeting, Corporate overruled my team’s favorite locations, and narrowed the choice to Santa Clara or Stanford Park. In a fit of pique, I just responded, "OK, which is the furthest from this room? We'll take Santa Clara!"



New F&T Headquarters in Santa Clara, with "Lake Bagley" in front

Since we built a new building complex from scratch, there has always been a bit of controversy on the architectural decisions. Three sides of each building have high narrow windows, while the north sides are fully filled with windows. The feeling is described as more of a castle with defensible narrow windows, rather than the open ends of buildings we left at the Stanford facility. Our objective was to make an environment without too much distraction with things going on in front of the facility.

We also chose to install a nice calming feature across the front, a cool reflecting pool of water, about 2 feet deep. It served a double purpose, beyond its people-oriented benefit, in that it could be called upon by city firefighters who would be attacking a fire in the buildings to use as a readily available water source. Almost immediately, other division wags irreverently proclaimed it “Lake Bagley.”

An Accidental Firing and the Laser Interferometer, 1971

Ron Potter had identified the computing counter as a product "he'd like to see HP make one day." When the Cooley-Tookey algorithm came along, Ron saw a way to radically exploit Fourier analysis in a powerful new instrument concept. This turned out to be a software answer, which was new to a hardware oriented team. Coming in one day frustrated over late deliveries, I sharply confronted Ron on his progress in front of his team. The problem: software still seemed invisible to me, which it was, and it was my fault. Ron said, "You fired me." He quit.

Electronic distance measurement had been using reversible counters to count off the wave lengths of a single laser, for extremely precise dimensional measurements. I proposed the use of two laser frequencies, which could provide compensation for a number of limitations. Len Cutler showed this could be done with a single laser. The key to durability was to avoid any gluing of elements together inside the laser's glass envelope; rather to hold it together with pressure only. The result: a patent, HP making its own lasers and a laser interferometer product capable of measuring to millionths of an inch. Ideal for machine tool accuracy, it positioned HP as a world leader in this market. To demonstrate the

The HP 5525A Laser Interferometer

interferometer we set up a slant range measurement to the top of a Golden Gate Bridge tower and displayed the vibration of the structure.

Decades of Creativity and Innovation at F&T Division

In my 2.5 decades of managing the F&T Division I found real satisfaction and pride in the amazingly creative engineers and their stellar products. This 1960 - 1980s period was high tech at its finest, both INSIDE HP and in the industrial and scientific world OUTSIDE. The Space Race was in full swing to put a man on the moon, requiring measuring instruments of every variety. The military was building new electronic systems of all types, radars, communications, navigation, electronic warfare, command and control. Commercial communications were pushing along the same paths to new spectrum technologies, microwave multiplex links across the US, mobile communications before the Cell Phone revolution, commercial satellites for across-the-ocean links. Long before fiber-optics.

When you think of all of the hundreds of thousands of transmitters that were involved, it could make your head spin. But more importantly for HP, because of legal rules of the use of the public frequency spectrum, every one of those transmitters was required to meet key operating specifications, dominantly control of the transmitted frequency. Enter the Frequency Counter products which HP provided early on, and which came to assume the market leadership. The counters provided the absolute accuracy with their sophisticated quartz time bases in their high-tech temperature-controlled ovens.

HP 5245L-5253A Counter-Converter

There were literally a dozen families of HP frequency counters, from inexpensive, low frequency models like the 521, to the computer-aided 5345L which took control of the market. The 5245L was a typical winner, which took the place of the large heavy 524B (120+ pounds). It was one of the earliest executions of counter technology using semiconductors, and the NIXIE® tube readout display. Prior late models of the 524 had converted to the NIXIE, but this lightweight gem was a real breakthrough at 35 pounds, and the workhorse of the HP line for almost two decades. It featured a plug-in architecture, such that the product could be customized for various frequency ranges and functional performance. These kinds of plug-in designs assured that the mainframe would live beyond the normal instrument life, as the addition of new plug-ins would extend performance and match new customer applications.

The HP 5245 Frequency Counter, with HP 5257A Transfer Oscillator installed. Other Drawers above, left to right: HP 5251A Frequency Converter, HP 5253B Frequency Converter, and HP 5252A Prescaler.

One plug-in that was particularly powerful was the 5253A, which covered the 500 MHz range by heterodyning down the unknown signal-under-test against a harmonic of a 50 MHz precision internal standard. A step-recovery diode (described below) produced the rich comb of harmonics past 500MHz, and a mechanically tuned filter selected an appropriate harmonic, which was subtracted from the unknown signal and the result counted by the counter. The 5254A ran the frequency coverage up to 3 GHz.

When it became time to retire the 5245L, it had seen a 19-year run of success. Boston Field Engineer, Vince Yaras made arrangements with our model shop people to fashion a unique plaque, using a real front panel from a 5245L. When he made the presentation to me, Vince noted that HP had shipped nearly 38,000 units, averaging 2000 units per year. Now THAT is a real innovation.

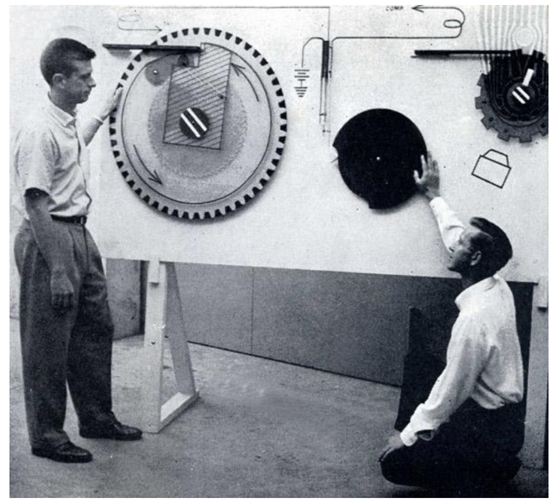
At an "instrument retirement" ceremony, Vince Yaras presents Al Bagley a plaque representing a highly successful 5245L Frequency Counter.

HP 560A Digital Printer

While frequency counters gave precise data in digital form, lab engineers and production test personnel found it extremely tedious to record such readings manually in a lab notebook or test card. It remained for Ed Hilton to head up a team that created HP's first digital printer. No technician could write as fast as a digital counter could measure! Nor could a technician be available hour after hour for a test running for a long period.

HP 560A Digital Printer

The result of these considerations was the Model 560A, introduced in 1956. It received voltage outputs from each decade module in the counter, and converted that to the print wheel position at print command. The Model 560A featured a printing speed of five, 11-digit lines per second. The 11-digit line allows secondary or coding data to be entered simultaneously with counter primary data. For example, several columns might encode the time of the data printout. It was an immediate success. The staircase voltage method of transferring data from the each digital (NIXIE) displays seemed unusual, but cleverly required only a single wire per digit rather than 4 that were later used for BCD connections. This digital printer demand demonstrated a real customer need for data logging and data management that would later spell success for products that could transfer their measurement data to desktop computers and other systems of data acquisition.



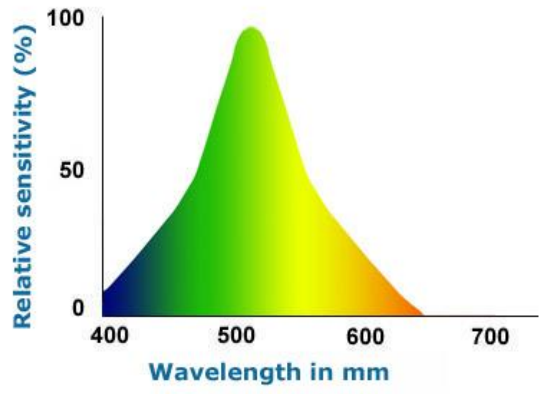
Al Bagley,(left) and Ed Hilton shown operating mechanical mock-up of Model 560A Print wheel mechanism. From a 1955-1957 supplement to the 1954 anniversary issue of WATT'S CURRENT. Courtesy of Hewlett Packard Company

HP 5300 Counters

This series of counters were highly portable, battery operated, and yet powerful high performance machines. One of their main characteristics was that they utilized some of the first production of LED, light-emitting-diode numeric displays. This was the same period as the HP-35 electronic slide rule was rolling out. It used monolithic displays only 1/10th inch high. Our counter used dot matrix digits in a 4 x 7 matrix, which made it readable at arm's length and beyond, with excellent readability. Ian Band was project manager, and early on made the decision to go with LED, even though other display technologies were offered. Liquid crystal displays were not yet reliable enough to commit in a rugged counter as this one was.

HP 5300A - The Versatile Snap-Together Concept

Another interesting hangup threatened Ian's decision. All projects in all divisions of those years were subject to an annual visitation by the top management from corporate headquarters, and this means Dave and Bill and Barney Oliver and top marketing execs. The idea is not only to show off the entire division and its product line, but to engage these experts to review most of the new products coming out of the lab. In those early days of LED technology, the red light emitting from those diodes was 655 nanometers. This is a red color that is right on the edge of human eye reception sensitivity. Ideally, we would have liked the red to be shifted a bit towards orange and yellow, but with our materials of those days, 655 is what we were happy to get, with any hope of reasonable yield.



Normal eyes have only about 10% sensitivity to dark red

The problem. Bill Hewlett. The chart shows that even ordinary eyes are down at 10% sensitivity at 655nm. It turns out that older eyes start to lose even more of their sensitivity at the far red end of the eye reception. We compensated for that by turning up the intensity of the red light output. Unfortunately that turns out to cause in some people, a physiological effect of making them "tense," without knowing really why. So Bill would look at these displays now being chosen for new products from instruments to desktop computers, and just say he didn't like those numbers. Seriously, if there had been any serious alternatives, Ian would have had to redesign.

Quartz Crystal Lab and Production Center

The heart of all frequency counters is the quartz crystal oscillator, housed in a temperature-controlled oven, and manufactured with the utmost care. The quartz controls the time base oscillator and thereby provides the basic accuracy of the frequency measurement itself. By specifying the long term stability of that oscillator, per day or month or year, the operator knows the confidence level of measurements made between calibration cycles.

The manufacturing process for producing the crystal component is highly dependent on technical and scientific knowledge of the crystalline structure of the quartz. For best performance over temperature ranges, the slicing saw orientation vs the crystal atomic lattice must be carefully controlled. In the final surface conditioning and metal depositions, clean room provisions are followed. All these considerations led us to conclude that we needed to fund the building of our own quartz lab. Around this point in time, HP also hired Don Hammond, who came to us from an advanced crystal lab in Colorado, and added immeasurably to our scientific knowhow in the theory and practice of quartz standards.

This extra science led us to two innovations that relied on quartz. 1) While the normal instrument usage of quartz sought to MINIMIZE the effect of temperature changes, it was possible to choose a different saw slicing angle that would MAXIMIZE the temperature effect. In that way we were able to build a highly precise temperature sensor. 2) We also found that over-pressure on a quartz crystal used in an oscillator would cause a change in the oscillator frequency. This led to a precision pressure sensor capable of sensing several thousand pounds per square inch. An instrument based on this effect became useful for oil well exploration when the drillers wished to know the down hole pressures for diagnostics.

Deep scientific knowledge of the crystal element led to mathematical research on the purity of a quartz oscillator. While a design engineer wishes to have an output signal that would be represented by an absolutely pure spectral line of frequency, any real-world oscillator gets noise entrapped in the preferred pure signal. The noise shows up as a performance deterioration called "fractional frequency deviation." If such oscillators are used in a communication receiver as a local oscillator, this noise factor transfers to the detected desired modulation as a signal to noise degradation.

These considerations led our laboratory to become real experts on the finest performance oscillators and to construct measurement apparatus that could actually measure the short term noise characteristics. Just another reason that our decision to build our own quartz lab and production was a smart call.

Development of the HP Interface Bus

Arguably one of the least appreciated breakthroughs in instruments and measurements of the 1970s was the HP Interface Bus. The concept of programming the control of instrument functions and accepting their measurement data was a gleam in the eye of systems engineers for decades. Early attempts used brute force methods like mechanical motor drives to tune signal generators under program control. Hardly any measurement instruments were designed to tap off their measurement data. These practices generally showed up first in the aerospace industry, where full scale tests of airframes under stress conditions of vibration or wing loading could be recorded on multi-pen strip chart recorders. Each flight test was such a unique (and costly) event, that multiple channels of vibration, temperature, stress, acceleration and other parameters were telemetered to ground stations. Those performance data streams were invaluable for design diagnostics and in case the flight met with a sad end.

HP's first attempt at instrument control and data acquisition was the 2116A computer, in the mid-1960s. Our legend says that Packard was not at all interested in getting into the computer business. But the project team cleverly designed the architecture to feature 14 Input/Output cards on the bottom, one for each instrument to be controlled. The concept worked extremely well, except that each and every instrument had to undergo serious re-design to allow its internal circuitry to be interfaced with the computer card. Since the quantity to be sold was relatively small compared to regular production quantities, it was not an easy sell to project management. The system test people were obviously willing to pay some premium for measurement automation, but that cost also had limits.

Futurists at HP and in my lab in particular saw these poor solutions in industry, and the drawbacks to the 2116A system controller. Measurement software was not scalable or very transferable from one application to another. Nor did that system solution meet the needs of small scale measurement automation, for example, on an individual design engineer R&D bench, or a production test line with little test budget available. So, as less expensive desktop computers, like the 9820, were rolling out of the HP facilities at Loveland, a consensus developed to find a general purpose information and control bus architecture.

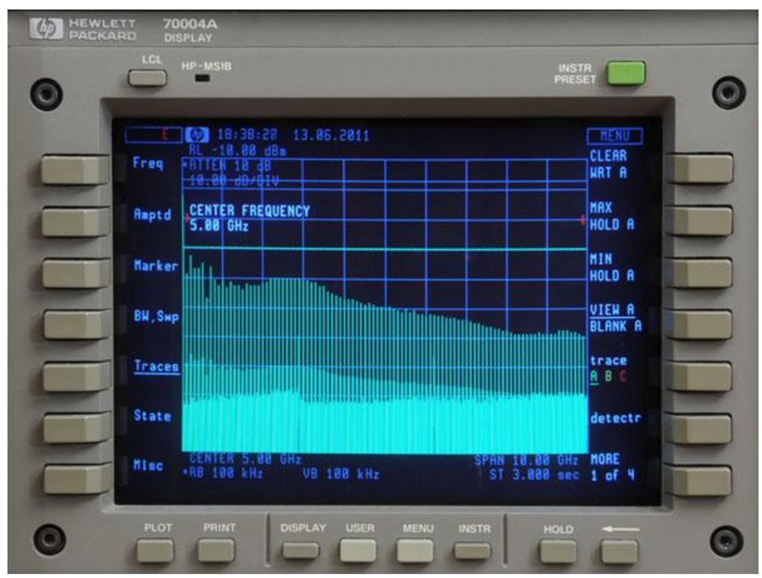
My point man in this difficult coordination project was Dave Ricci. Obviously the entire HP corporation would have to come on board ultimately because instruments from most measurement divisions would have candidates products to join the programming list. But in the early stages, only F&T and our Loveland (audio-video and desktop computers) had the most incentive to find an information bus that could transfer data and handle command signals. In the end, a serial data bus design won out, with a number of command lines for hand off, along with stackable blue-ribbon connectors that became recognizable to every engineer in the world, they were ubiquitous. Dave and Jerry Nelson of Loveland did a masterful job, not just in the bus architecture, but in their coordination with all the other future division participation. They optimized

Early HP-IB compatible instruments and controlling computer the design for speed and yet simplified the instruction set for easy modification of the interface inside the instrument and the software and firmware commands. And they paid a lot of attention to making it easy to program.

Almost as important and getting the HP Interface Bus completed, a further question came up. Should HP take its patents on the HP-IB and run alone to customers, with the potential of other competitors designing competing automation? Or should HP share the design specifications with industry and create an open standard? I believe that we made the right decision when we set Don Loughrey to the job of preparing the Interface Bus to be accepted by the IEEE as an open standard. This process was NOT trivial and it took many months, and widescale industry cooperation. But it finally became IEEE-488, and was re-named the General Purpose Interface Bus. In some eyes, this too was one of HP's fine hours.

Frank Boff's Step-Recovery-Diode

I wrote this story for John Minck's HP History 10 years ago. In the early 1960's, F&T engineer Frank Boff was working on harmonic-comb generators to extend the frequency range of our counter frequency down-converters. One circuit was showing non-intuitive results, with high frequency harmonics that were much more powerful than theoretically possible from a non-linear resistive device such as a diode. To investigate further, he borrowed an early lab prototype of the HP sampling scope to display a time-domain picture of what was producing such rich signals in the frequency-domain. When he finally got the fuzzy picture focused, he didn't see the expected chopped-off top of a sine wave, produced by a diode, but instead saw a sine wave that rose smoothly to almost full amplitude, then suddenly crashed to near zero amplitude.



Frank Boff's extraordinary creation shows in this spectrum shot of a precision100 MHz oscillator with harmonics flat out to 10 GHz. It revolutionized microwave counters, spectrum analyzers and signal synthesizers for decades.

At that point, serendipity entered. Frank remembered seeing a paper in the IEEE proceedings, which theorized that such a waveform might exist if a device exhibited a non-linear charge-versus-voltage curve instead of the non-linear current-versus-voltage curve that defined a normal diode. Frank reviewed the article, restudied the strange wave-shape, and proclaimed that what he had taken to be a non-linear resistor, or diode, was actually a non-linear capacitor under certain conditions.

What he had developed was a variation of the well-known P-N diode which enhanced the stored carrier phenomenon, and achieved an abrupt transition from reverse-storage conduction to cutoff. Remarkably, it was able to switch tens of volts or hundreds of milliamperes in less than a nanosecond. The result was the ability to generate milliwatts of harmonic power at 10 GHz from stable oscillators running at 200 MHz. That device, discovered by an extraordinary engineer, was called the "Boff diode" for a number of years. Sadly, the name was later changed to the more-generic "step-recovery-diode," for marketing reasons. Boff is retired back in his home country, the UK, but I believe that the name Boff diode should have been maintained to recognize a truly significant invention.

HP exploited this new power in a wide variety of products, giving us dramatic and proprietary performance for some years. HP counters used the harmonic-comb signals to down-convert test signals for counter coverage to 18 GHz. The HP 8410 network analyzer used a two-channel version to down-convert microwave signals for characterizing scattering parameters to 18 GHz. Sampling oscilloscopes, after prototypes were used to discover the effect, in turn, used the diode to generate large-voltage sampling impulses, of extremely narrow width, for measurement of fast-transition test signals in the pico-second range. A whole generation of HP signal generators and sweepers used the rich harmonics to stabilize and program microwave signals using the technique of indirect frequency synthesis.

About a decade ago, I was on a trip to England and called Frank's home. His wife, Rae, answered and told me which train to take from London to visit them. When I arrived the station there, I got out and saw Frank kind of wandering around absent-mindedly. He was in the early stages of Alzheimers disease. He finally recognized me and drove me the short distance to his house. When we opened the front door, the first thing I saw was a very fine bronze sculpture of Frank. His wife was a quite talented artist in oils and bronze. Some of her beautiful paintings decorated their walls. When I went into the kitchen to say "hi," she let me know that she had decided it would be pleasurable experience for Frank to meet me and drive. It may have been about the last time he did it.

We talked about his life after leaving the US and HP. Besides being executive VP of a small electronics company, he had done a fair amount of teaching at Kings College in London. He showed me a paper wall-poster announcing one of his lectures. The title was something like "Frequency Measurement Among Peoples of the Pacific Coast." I am sure the audience enjoyed his relating his experience at HP following his time at another "Pacific Coast" counter company, Berkeley Scientific. He said he had thought he was teaching R&D, but learned later that the college referred to his courses as management training, because he was the only professor who had worked in an electronic company. We were so lucky to have had him with us.

The First Scientific Calculator, 1972

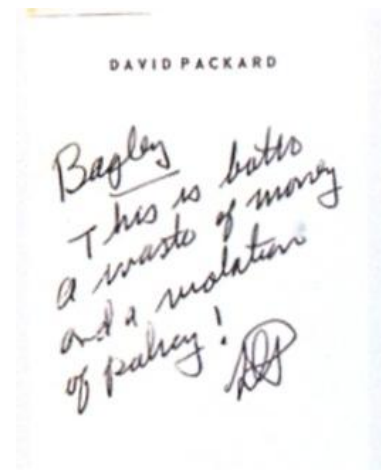
Two aerospace company engineers approached HP with what appeared to be a revolutionary idea to improve calculators beyond "four bangers" (add, subtract, multiply and divide), a business in which HP was definitely not interested at the time. Those engineers had developed this idea based on gun firing computation for an Air Force bomber. But I was intrigued, and assigned my top digital team to investigate. The verdict, "It'll work!" Armed with this analysis, I approached David Packard. In the end it wasn't my division that got the project, but that was how Hewlett Packard came to pioneer full function scientific calculators.

How not to get into the $1 M IC Circuit Test Business, 1974

HP had always been in the circuit test business, as a basic necessity of its instrument business. By that I mean that we made instruments for customer engineers to use when inventing their own electronic circuits, which were then executed onto highly repeatable printed circuit board. When circuits moved off of printed circuit boards and began to be super-integrated into ICs, the old paradigm changed. The electronic technology was going to be ALMOST ALL chemically created integrated circuits. So I assigned a new HP engineer, Charlie Trimble, out of Cal Tech to look into IC testing.

Charlie and his team determined the machines that would be needed to do the job would sell for $1million each. I attended the product review meeting with the "guys from down the hill," the corporate guys, who said, "It is not a fit for HP. If we did know how to make it we wouldn't know how to sell it." One of Charlie Trimble's team members, Steve Bisset, quit HP, started Megatest on a shoe string using his own money and made and sold many of those million dollar machines. This was a lesson not lost on Charlie Trimble, who later left HP to create a whole new business of GPS navigation products.

Packard's (mostly) Hands-Off Management Style, 1975



Memo from Packard: "Bagley, This is both a waste of money and a violation of policy!"

The guiding philosophy at HP was that any engineer could spot a need and propose a product to fill it. Divisions were created to help stay close to the customer and encourage an independent and agile response. While Hewlett and Packard were obliged to focus widely, they occasionally did get directly involved at a detailed level. As an example, in this note (above), David Packard dipped down into an issue at my Santa Clara Division. It had come to his attention that my marketing manager had proposed a color brochure to promote our Division products to the HP sales force. And perhaps gain a small advantage over other division's products. It had escaped my attention, but the rule was that the expense of color was felt to be justifiable when a brochure was aimed at customers, but not at the sales force. The note, obviously demonstrated the clarity of Packard's management style.

Moving up to Corporate as Engineering Manager, 1976

In October, 1976, I was asked to move up to Corporate as the Engineering Manager (EM) for all instrumentation an HP-wide, world-wide role. The promotion at first seemed disappointing. Having been raised to the idea that operating divisions were to act as autonomous profit centers it seemed unlikely a corporate EM could make much of a contribution. I was really feeling down at that moment. Our division had five product lines, the sales of which were all dipping together - it was looking bad. I had the idea that a Corporate-level Engineering Manager position was for technical people who didn't know how to manage. Sales for the Division's five lines came roaring back the next year, but the change had been made. It was a bitter pill. A corporate staff position was a frustrating role for a person like me, used to line management.

Bill Hewlett retires; John Young becomes CEO, 1978

My new position was indicative of HP's greater focus as a computer company. I saw HP pushed toward an "extremely tight interlocking company." Autonomy was being reduced at the divisions. Bill Hewlett retired as president and my long-term colleague, John Young, became the first "non-founder" CEO. But then I found my initial discouragement had been "unnecessary." I realized that my new corporate role was a platform to promote several early HP values. I appreciated the early objective of the firm: "make a contribution," a gung-ho, can-do spirit which I had experienced early and often at HP.

So as I took the new role, "contribution" as a stated value had been dropped; especially it seemed, by the new computer divisions. I also liked the work value of "integrity," as in giving customers more than they expect. It had been often promoted verbally by Bill and Dave. I recall when Dave and Bill were approached at a trade show by two men asking, "Can we get away with lower quality when selling in Europe?" They laughed the guys out of the room. In my new, corporate role I met the president of the Japanese company Ricoh at a dinner party. The man bowed deeply and said, "You are very fortunate, HP is the best there is."

Promotion of Early Values in a Large Corporation, 1980

The early years of the Hewlett Packard work culture were characterized by a very informal and congenial atmosphere. This came in large part based on the personal styles of Dave Packard and Bill Hewlett. They encouraged management by walking around, management open-door policies, and the pioneering of significant employee benefits like family medical coverage, stock purchase plans and a remarkably generous pension contribution plan--long before 401(k) was introduced.

The casual work environment did not mean sloppy planning or execution. Dave and Bill ran a tight ship on work standards. And yet, there was time for fun and off-hours camaraderie. There were off-site meetings and annual reviews which took us mid-managers out of the work environment for several days to work on future planning, and a little fun at the expense of top management. I confess that I was a member of a small group of managers who created what became known as the annual Monterey Meeting banquet posters.

For about 50 managers who came from middle management of our factories and from the Field Sales Reps, at the time of the evening banquet, about 40-50 of these typical posters with informal pictures of the subject manager were combined with some funny cartoon messages that were enjoyed by all, as they entered the banquet room for the formal dinner. Even we ringleaders were not spared the "honor" of getting roasted by some of our other creators. These off-site meetings at Monterey were discontinued in the late 1960s.

I got some of my own medicine when I was roasted on this typical Monterey Meeting banquet poster.

Such personnel informalities had to end as the corporation moved into the billion dollar revenue stages. HP always remained a very friendly place to work, but it had to be subject to considerable new rules to comply with legal regulations and workplace considerations. Bill and Dave's "HP Way" which was cultivated when we were small, continued on through those decades when we hit $50 billion annual revenues. So when I moved to the corporate team, I was determined to adapt those small-company values to the needs of a giant industry power.

So I established my big challenge as the promotion of HP's early values in the larger, more computer-oriented firm. The problem was the greater difficulty for those building computers in knowing and empathizing with just how their products would be used by their customer; harder than it was for the instrument engineer.

I Organize the Engineering Leadership Conference, 1983

In pursuit of my role as HP Corporate Engineering Manager, I initiated a conference of all of the Instrument Divisions' engineering managers featuring San Francisco-born 1968 physics Nobel Prize winner Luis Alvarez. The theme of the conference was "R&D productivity, avoiding slack periods created by bureaucracy." Alvarez spoke on leadership and issues of ego. Alvarez asked, "What do you do when someone says 'you can't, it's impossible'?" It was part of my promotion of the long time HP value of contribution, that gung-ho, can-do spirit.

I Retire from HP at age 62, 1986

ALAN S. BAGLEY
ENTREPRENEUR

Old Bags at last had his fill
Of lesser Gods from down the hill.
So he'll retire come end October
A thought that makes him somewhat sober

Ideas galore under Bagley's aegis
Made Santa Clara's line prestigious,
With laser light and methods quizzical
They soon did measure distance physical.

When all is done. Bags claims in jest
That time has come for God to rest,
And with these tools right off the shelf
He thinks he might do the same himself.

Three stanzas from retirement party poem

In October, 1986, I took a lucrative early retirement package offered by HP. I was 62. In the early 1980s HP had moved rapidly toward a focus on computing and peripherals, particularly printers, and less significantly on scientific instrumentation, which was my principal expertise. I stayed in touch with my fellow HP retirees as time passed, and watched the fortunes of the company proceed in a manner which was surely non-instrument.

In 1989, HP celebrated its 50th anniversary. It had 95,000 employees and sales of $11.9 billion. I was proud to have made significant contributions for all but 13 years of that history. The growth from my starting day was stunning, from when HP had merely 130 employees and sales of $2.2 million. Ten years later, Hewlett Packard as a focused instrument company would be no more. In 1999, HP would spin off its instrument divisions to form Agilent Technologies, a new $8 billion, 47,000 employee company, itself number 212 on the Fortune 500 list of companies when it was formed. I did continue a close relationship with HP, with some volunteer activities, helping to develop the oral history of the Firm and to capture the experience of its founding employees such as himself.

Alan Bagley interviewed a number of senior HP managers for their oral histories. In this case Art Fong sat for his remembrances about his 40-year career as an HP engineer, some of which served as content of Art's own HP memoir in this archive.
from MEASURE Magazine January 1991 - Courtesy of the Hewlett Packard Company

Retirement Activities

In one of my later trips, I was invited to participate in the European launching of a large experimental yacht by long-term friend and former HP colleague Tom Perkins, a Silicon Valley Venture Capitalist. It was rumored in yachting circles that the construction cost ran to about $300 million dollars. Tom lovingly named it the Maltese Falcon. It was more than 300 feet long, with total state of the art construction techniques using carbon fiber technology. At one point he claimed that he had bought out the whole world supply of carbon fiber materials.

The masts were rigged with total motor control of the sails, all of which were computer activated. In the Leslie Stahl interview on 60 Minutes, Tom showed the operation with his laptop at hand. A remarkable concept and surely commensurate with Tom's lifetime of yachting and his vision.

In 2007, I joined the Board of SETI, the Search for Extra Terrestrial Intelligence organization. I also sat on their Executive Committee.

Acknowledgements

In 2007, my son-in-law, Terry Pettengill, compiled and illustrated my lifetime in a Timeline story, with about equal presentation space for my family life and my HP career. It was well detailed and I was proud to have it to hand on to my children and grandchildren. When Marc Mislanghe came looking for more contributions to his website, HPMemory.org, in the form of HP Memoirs, I suggested to John Minck that the Hewlett Packard sections of my Timeline might be adapted for the website format. John took that as a challenge and worked to produce this content. I appreciate his efforts for a job well done, and hope it brings some reading enjoyment in recalling some great years at HP for everyone.

Alan Bagley
--Los Altos, CA
January, 2014

To prove that there is life outside of Hewlett Packard, Al's very busy life story included raising this dynasty. The Bagley Clan (partial), in 29 Palms, CA, June 26, 1997, Al, under arrow.

HP Memories

This memory of Al Bagley's career at *hp* results from the work of the www.hpmemory.org website of Marc Mislanghe, who with John Minck (and Al) edited and published his Memoir.

One of the main objectives in starting this website five years ago was (and still is today) to get in touch with people who have worked at *hp* from the birth of the company up to today. We are interested in hearing your memories no matter what division or country you worked in, or whether you were in engineering, marketing, finance, administration, or worked in a factory. This is because all of you have contributed to the story of this unique and successful enterprise.

Your memories are treasure for this website. While product and technology are our main concern, other writings related to the company life are highly welcome, as far as they stay inside the *hp* Way guidelines.

Anybody Else? Please get in touch using the Contact US form at "http://www.hpmemory.org."