

HP: A History worth Preserving

a presentation to

the HP Retired Employees Club

in the HP Building 20A auditorium

by Kenneth A. Kuhn

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[1 Oscillator picture with title]

It is a great honor and privilege to be here presenting my work on vintage HP test equipment and history in general. First, I would like to thank Chuck House, Don Higgins, Carol Nakomoto, and everyone else who made this possible.

The title of my presentation is *HP: A History worth Preserving*. I own a very large collection of vintage HP test equipment that I both use and restore. Part of my web site is devoted to HP history and is often visited by people all over the world. A big question is, "Why do this." The main reason that I own the collection is for the pleasure of using it. It is not just a static museum. I am an electrical engineer who designs electronics and I appreciate clever innovation. I have learned much by studying how HP equipment was designed.

I had known of the Hewlett-Packard Company since the late 1960s when I was in high school and studying electronics. My first exposure to HP products was in 1972 when I was an electronics student at a technical college. I remember doing many lab experiments using a 200CD oscillator. Later, when I was studying electrical engineering at Auburn University, many of the labs had various HP test equipment. I never dreamed that years later I would own this equipment.

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The artifacts in my personal HP museum serve as powerful reminders of what can be accomplished when people work together. To examine an instrument made many years ago reveals that those involved must have enjoyed a high degree of camaraderie in their strive for excellence. That is what makes the history so valuable. History is the foundation upon which we build our future. Forget history and there is no foundation. The history of HP is also comprised of great human concepts that transcend the artifacts in my collection. You know this – you were there. At HP these concepts shine brightly and are visible and inspirational not only to an interested outsider such as me, but to people all over the world.

I am here to present my work because HP as a company and you as a part of that company accomplished great things that have made a real difference in the world. Much of the equipment you were a part of creating thirty or more years ago is still used, maintained, and appreciated today. Just the mention of those two famous letters, H-P, immediately conjures images of the highest things in life regardless of whether one worked at HP or not. HP is at the top of a short list of companies widely admired. This is special.

Bill and Dave made it possible. Many thousands of you made it happen. HP is respected not just for the fine engineering that goes into its products but also for the human side of the business where people are truly valued. HP popularized concepts such as open door, first name, flexible hours, casual dress, profit sharing, and health insurance. Indeed, the company I work for emulates all of this. So even though I never worked at HP, I am much better off because HP exists. That is as good a reason as any to want to understand and appreciate its history.

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[2 Trivia slide]

Before I continue let me pose a trivia question about the HP product line.

What product developed by HP in the 1960s based on a concept of Barney Oliver is still manufactured today and sold now by Agilent Technologies by its original model number? The answer will be provided at the end of my talk.

[3 Main row slide main_row.jpg]

Let's now take a pictorial tour of my home electronics shop. To keep this brief I am going to go quickly and what you are going to see is only a small fraction of the total collection.

This picture is of my collection of vintage HP oscillators and meters. Except for two models, I have at least one of every different oscillator HP ever produced. My collection consists of instruments I regularly use and instruments that are mainly museum pieces. The intent is for every instrument to eventually operate to original specifications. I have a long ways to go. I hope to retire young to have more time to devote to my favorite pastime. One thing to keep in mind while looking at all of this is the countless thousands of HP employees whose dedicated handiwork is represented. That is perhaps more awe inspiring than the collection itself.

[4 200A slide oscillators1.jpg]

In the upper left are two HP200A oscillators. Next is a 200C stacked on top of a 200BR (R indicates rackmount). The Walt Disney Company made the famous purchase of a number of the 200BR units. The second row begins with an early vintage 200B unit that has the rounded corner case. A newer vintage 200B is to the right followed by a pair of 350A attenuators.

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[5 200B rounded corner slide oscillators2.jpg]

Here is a close-up of the vintage 200B. Note the rounded corners and the engraved panel lettering. This is one of the oldest instruments in the shop and is believed to have been made in 1942. These are very rare and I had to fight quite a battle to obtain this one.

[6 200C and D slide oscillators3.jpg]

Here is a 200C and 200D oscillator. The 'C' version operated up to 200 kHz and the 'D' version operated down to 7 Hz. To the right of the 'D' unit are an assortment of transformers used with the oscillators. The next row shows a 202D oscillator that could oscillate down to 2 Hz. HP made a variety of oscillators to cover the complete frequency spectrum. Next is HP's first square wave generator, the 210A. To the right is HP's first power supply, the 710A.

[7 500A slide oscillators4.jpg]

This row shows HP's first frequency meter, the 500A that could measure up to 50 kHz. Next is HP's first distortion analyzer, the 320A. To the right are two early laboratory amplifiers, the 450A and 451A. The bottom row shows a 325A distortion analyzer and a 202B oscillator which has the distinction of being the lowest frequency oscillator based on Bill's design and could oscillate down to 0.5 Hz.

[8 HP320A slide oldest.jpg]

This 320A distortion analyzer is also one of the oldest instruments in the shop and was probably made in 1942. It was in pathetic shape when I acquired it. It took a lot of cleaning and TLC to make it look and operate like new.

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[9 HP201B slide oscillators5.jpg]

Here is a 201B which was a high power version of the 200B that could deliver about 3 watts. Next is a 200H (H for high frequency) that could oscillate up to 600 kHz. The next row shows a 200I (I for interpolation) that had narrower frequency ranges to allow for better frequency resolution. Next is a 200T (T for telemetry) with special frequency ranges for testing telemetry systems. The last row shows the very popular 205AG which was just about a complete audio test station in a single unit. Next is a 206A low-distortion oscillator used for testing fine audio systems. It could generate sine waves with distortion less than 0.1 percent.

[10 HP200CD slide oscillators6.jpg]

Here is a row of various vintage 200CD oscillators. The 200CD oscillator was designed by Barney Oliver and was an improvement on Bill's design. The 200CD had a very wide frequency range and replaced models 200C, 200D, and 200H and ultimately even the 'A' and 'B' as it covered all their functions. The unit on the left is from the very first production run in 1952 and the unit on the right is among the last ones made in the 1980s. This very popular oscillator was sold between the years of 1952 and 1985. The various units in-between represent evolving versions from the late 1950s through early 1970s.

[11 HP200AB slide oscillators6.jpg]

This slide shows a 200AB which was introduced in 1952 and combined the functions of the 200A and 200B. Next is a 201C which is a newer version of the 201B. A 202C low frequency oscillator is to the right. Next is a very novel oscillator, the 207A. This oscillator used a clever network extension to Bill's design to achieve a frequency range of one thousand to one in a single band covering 20 Hz to 20 kHz with a convenient logarithmic change

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in frequency. It was very popular for measuring audio amplifier frequency response. The small unit on the right is a 204B which was the first solid state oscillator based on Bill's design. Art Fong will recognize the two units on the last row – the 650A oscillator and the still very popular to this day 606A signal generator he developed. The 650A carries Bill's Wein bridge design to the high frequency extreme of 1 MHz. It took a new concept, the ring oscillator suggested by Barney Oliver before he was employed by HP, to attain the top frequency of 10 MHz. As I understand the story, the project to develop the 650A was having problems and Art Fong was drafted to save it.

[12 HP400A – meters1.jpg]

If the oscillator was Bill's genius then the voltmeter was Dave's. For HP's first AC voltmeter, Dave put the rectifier diodes in the feedback of a high gain amplifier to stabilize the calibration and to also make a linear AC scale – two very novel concepts at that time. Using a feedback stabilized amplifier virtually eliminated calibration drift as the vacuum tubes aged. These significant contributions to technology are not as well known as that of Bill's stabilized oscillator but are equally as great. Here we see a 400A and a 400B.

[13 HP404A slide meters2.jpg]

Here is a battery operated version of the AC voltmeter, the 404A. Next is a 410A general purpose meter that could measure DC voltage, AC voltage, and resistance. It could also measure current using external input shunts. The 410A Volt-Ohm meter incorporated a special vacuum tube diode in the probe to measure signals in the hundreds of MHz. Next is an improved version, the 410B. The 410B is still very popular to this day and commands

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a high price on the auction markets. The last meter is a 412A general purpose volt-ohm-milliammeter.

[14 – other oscillators and meters slide meters4.jpg]

Here are some other oscillators and meters in the vintage collection. There is not time to discuss them. I own most products HP made in the first 20 years.

[15 HP Journal slide – Art hpj_8551a.jpg]

From reading the HP Journal I had known of and highly admired Art Fong and wished that I could have worked under him – I could have learned so much. This picture is from the August, 1964 issue of the HP Journal and shows Art Fong and Harley Halverson with their recently developed 8551A spectrum analyzer. Although I did not know Art personally when I first read this article in the early 1980s I could clearly see in the picture and journal article that Art was a master of a complicated subject that always fascinated me. I could also see that Art was a very warm person willing to share all knowledge. I was inspired to make it one of my life's purposes to be just like the Art that I saw in this picture. My inspiration was confirmed a year ago when I had the great privilege of meeting Art.

[16 HP8551 slide DSC00846.JPG]

I now own two 8551B spectrum analyzer units. Both of them work although each needs some TLC to operate like new.

[17 HP803 slide hp803a417a.jpg]

In the 1940s Art improved on a concept by J. F. Byrne and developed the first direct reading high frequency impedance bridge known as the 803A when it was introduced in 1950. Unbeknownst to me in the Fall of 2005

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there was interest in showing Art with an 803A and its associated 417A VHF null detector in the documentary, *Origins*. But none could be found. Art found my web site and saw that I had a set. Art sent me an email asking about either buying or borrowing my set for the documentary. I responded that I would be glad to make the equipment available. As it turned out the production schedule was very tight so that was not possible. I told Art that I would be on the lookout for a second set that I would give to him. This is a picture of that second set I sent to Art last fall. They are now located in the Agilent History Center.

Art encouraged me to make a visit to Palo Alto and on this very week in 2006 my friend Glenn and I made the trip and spent many pleasurable hours discussing engineering and HP history with Art. I relate very well with Art because like him I have studied hard to be very good at what I do. I am also highly sought after to solve the very difficult problems and I too am known as a wizard. Like Art, I think carefully when handed a challenging problem and then provide the answers for the same reason that Art said, "I like to see things work well." That statement by Art is a great summary of the HP spirit. Art has many great stories and I hope that these can be recorded for history for it is an inspirational history worth preserving.

[18 Side shop table slide DSC00895.JPG]

Here is a view of my main shop table. There is too much equipment to list individually.

[19 Network analyzer slide DSC00896.JPG]

Here is a view of my 8410B network analyzer and various equipment stored under the table.

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[20 Left and middle shop slide DSC00918.JPG]

The instruments on my main table are organized by frequency spectrum. The left table is for low frequency work. The middle table is for medium high frequency work.

[21 Right shop table slide DSC00919.JPG]

The right table is for VHF to microwave work.

[22 Barney Oliver Stereo slide DSC00897.JPG]

No HP shop would be complete without a Barney Oliver stereo amplifier. As I understand the story, Barney designed this amplifier in the early 1970s after being frustrated with the amplifiers available commercially. Even by today's standards the amplifier has very impressive specifications – over 50 watts per channel and inaudible distortion. It also features various low frequency and high frequency filters to reduce power to the speakers at frequencies that are either beyond human hearing or that the speakers can not reproduce. That is a feature I have long thought should exist in audio amplifiers and it is nice to know that my thoughts paralleled those of Barney.

[23 Close-up of Barney Oliver Stereo slide DSC00898.JPG]

I acquired this amplifier from an HP retiree and it is used for classical music in my shop. It is my understanding that only about 400 of these were made in two separate runs. If anyone in the audience has more information I would appreciate it if you would share that with me as there is very little available history on this amplifier. As I understand it, the construction of these amplifiers was a labor of love in an after-hours production that had the blessings of HP management. Could such a project happen anywhere else but at HP?

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[24 Instrument storage area DSC00906.JPG]

Here I keep instruments that I have no place else to store. An improved rack system with much more space is being planned.

[25 Side view of storage DSC00902.JPG]

Here is a side view of the storage area.

[26 Main corridor slide DSC00887.JPG]

This view is of my main shop table as I enter the shop area of my basement.

[27 Bookcases DSC00844.JPG]

I maintain an extensive collection of HP manuals, service notes, catalogs, application notes, and HP Journals. Here you see about twenty-four shelf feet of manuals, six shelf feet of catalogs, and over three shelf feet of HP Journals. I have every HP catalog from 1945 to present. I have an almost complete collection of HP Journals from 1949 to 1999. Some of the manuals are from the very early 1940s and are done on a typewriter.

[28 Early HP catalogs DSC00911.JPG]

Here are my 1945 and 1948 HP catalogs.

[29 Slide of slide rule, HP25, HP35, HP45, HP80, HP41C DSC00907.JPG]

When the HP35 calculator was introduced in 1972 I dreamed of owning one. But it was only a dream as the \$395 price might as well have been \$395,000 as I was poor in those days. I was one of the last engineering students to use a slide rule as I did not have a scientific calculator. I could have bought one of the other calculator brands but I was holding out for an HP. In December, 1975, I bought an HP25 programmable scientific calculator for \$195 direct from HP. This calculator got me through engineering school. I still use it to this day in my shop – over 30 years later. In the short term, HP products are “highest priced.” But their value over time is very high. That is why HP is so respected. I now own several working HP35 calculators. In this slide you

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can see my old slide rule and my HP25 that replaced it. Next are an HP35, HP45, my father's HP80, and my HP41C. All work fine which is a testament to HP quality.

[30 HP Journal slide DSC00910.JPG]

In 1979 on the first day on my first job after I graduated as an electrical engineer my boss told me that reading the HP Journal was a job requirement. He had a very high respect for HP and used HP as an example of how to do things right. He handed me a stack of HP Journals to read. I was not familiar with the publication at the time but quickly realized how great it was. This became a job requirement that I was eager to fulfill. Some years later when my then boss neared retirement he gave me his collection of HP Journals. He could not bear to see them go to the land fill and knew I would take good care of them. Reading the HP Journal was very inspirational for me. I made it a point to emulate HP methods for doing my engineering work. When confronted with a challenging problem I always ask myself, "How would HP engineers solve this problem?" After a little thought I have the answer.

Inspired by the articles I read in the HP Journal and particularly by the obvious camaraderie and the short bios of key persons on a featured product, I came very close to sending my resume to HP in 1982 as I felt that I really belonged there. But I decided to remain in Alabama where most of my family was. I have done very well in Alabama so I have no regrets. But it is interesting to ponder what might have been.

[31 HP141A slide DSC00909.JPG]

My collection of HP test equipment began in late 1999 when an HP141A oscilloscope at the company I work for was on its way to the land fill as it

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was no longer working properly. This seemed like a cruel fate for such a fine instrument. I asked if I could take it instead and that was fine. In my home shop I determined the problem to be an intermittent connection and made the repair.

After repairing the 141 it occurred to me that there were a lot of other HP instruments that could be acquired inexpensively on the surplus markets and that whatever repairs might be needed would be easy to do. Thus began my collection. My next two acquisitions were the 302A and 310A wave analyzers. Both needed a lot of work but that was a pleasure to do.

I then became very interested in the history of HP. I discovered that very little information was available. There was no book other than Dave's "*The HP Way*." No documentary had been produced. The history portion of the HP web site although well done, left one yearning for a lot more. A search of various Internet sites showed very little information about HP. I knew that a great history existed and it shocked me that it seemed to be fading without notice. So in addition to collecting various HP instruments that I specifically wanted, I set about to do what I could to preserve the history in both equipment and documents.

I added an HP museum page to my web site that initially only had links to the short list of sites with information about HP. During my lunch hour I would search for more sites. I later posted a few pictures of my growing collection and described what I was doing. I began to receive emails from people who admired HP and were also frustrated that so little of its history was available. They were glad of what I was doing and encouraged me to continue. My web page has grown substantially and the number of other

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web sites with information has grown as well. Presently, there are five major private web sites devoted to HP. Each of these addresses a different aspect – calculators, computers, test equipment, documents, and product history and memories.

I receive several emails about vintage HP equipment each week from people in the United States, Canada, Australia, South America, and various European countries. Common questions that I am glad to answer are how to make repairs and historical information. It is great hearing from them that my assistance resulted in a working HP instrument which they treasure.

[32 HP200B picture DSC00789.JPG]

Last November I was contacted by the California Museum in Sacramento about borrowing one of my HP200B units to be used in a special year long display honoring David Packard in the newly created California Hall of Fame at a ceremony held last December. Of course my answer was yes. I am proud to have something from my collection in the Packard exhibit which will be on display until November. While I am here I plan to travel to Sacramento to take some pictures of the display to post on my web site. I took this picture of the oscillator just before I packed it for shipping. It was made circa 1943 has the rare feature of a mechanical fine tuning control.

[33 Picture of Malone's book, Yuen's book, Origins DVD case DSC00908.JPG]

I was very glad to learn in 2005 that Michael Malone would be writing a book, *Bill and Dave*. I had the pleasure of meeting him during my trip to Palo Alto in 2006 and he told me that my web site had been helpful in his research. I think Malone did an excellent job of connecting the fragmented dots of the HP story to convey for the first time a cohesive account of how the Hewlett-Packard Company became the great company that it is. His

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account shows that there is much to be learned from knowing and preserving the history of HP.

While reading an on-line issue of HPREC news I learned that Chuck House was also working on a book. His book was begun prior to Malone's and may have inspired a trend that resulted in Malone's book. I look forward to reading Chuck's book.

I recently discovered another book, *Bill and Dave's Memos*, edited by Albert Yuen who was a former employee of HP and has collected a number of significant writings and speeches of Bill and Dave concerning management and leadership. What makes this book special is that you are directly reading Bill and Dave as if they are speaking to you personally.

I very much enjoyed the *Origins* documentary and have watched it a number of times. My hope is that a full documentary will be produced in the near future and shown on the PBS series, *American Experience*.

I want to thank John Minck who was a very gracious guide last year during our visit. John gave Glenn and me a very grand tour of the many HP buildings and other sites of interest. It was one of the greatest experiences in my life. John's writings have preserved a lot of HP history that otherwise would have been lost. His *Inside HP Narrative* is must reading. It is so well written that as I read it I felt as if I was at HP involved in the experiences. We should all be very grateful for the countless hundreds if not thousands of dedicated hours John has spent recording the great history of HP. I encourage John to keep on writing. Every little story is another pixel that

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makes the big picture more clear and would be a detail lost forever if not written down.

In closing I want to thank everyone for the opportunity to present my work and for caring enough about HP's great history to attend. When I began my efforts in 1999 I was all alone. Now I am part of a growing community with the common goal of recognizing and preserving the history and great concepts of a company affectionately known as HP.

[34 Picture of Dave in Origins packard.jpg]

Near the close of the *Origins* documentary there is an excerpt from one of Dave's speeches and he makes a statement which I quote, "*I don't think it is useful to spend much time looking at the past. I think we ought to spend most of our time looking at the future because that is where we are all going to be.*" I understand what Dave is saying but I would like to make the point that knowing and comprehending what worked and did not work in the past provides a valuable guide to the future. The future should always be building on the past. Forgetting the past ultimately detracts from the future because the forgotten past will have to be rediscovered. Perhaps this should be the eighth tenet of the HP Way – *Foundation: Build the future on the foundation of a strong past.* HP certainly did.

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[35 Picture of Bill and Dave billndave.jpg]

Bill and Dave wanted to be treated and remembered as ordinary people who enjoyed very much doing what they did and felt everyone should share in that enjoyment. Their insistence on using first names was a masterpiece in dethroning any kind of deification that might be attempted to be bestowed upon them. It is tempting to want to honor Bill and Dave and the countless thousands of others who built HP with some grand monument. But they and you would all ask, “Why? What good can a monument possibly accomplish?” If we live our lives and treat the world and our fellow humans as Bill, Dave, and everyone else taught us by example, then their spirits can live on forever. *That* is the highest honor that can be bestowed upon anyone. It is not just a history of artifacts. It is a living future. That is the HP spirit.

[36 Trivia answer slide DSC00914.JPG]

Now it is time for the answer to the trivia question. In the mid 1960s, HP engineers developed the model 778D dual directional coupler for use with HP’s first swept network analyzer, the 8410A. This directional coupler based on a concept by Barney Oliver featured an unusually wide passband from 0.1 to 2 GHz. It is still manufactured today by Agilent Technologies and retains its original model number. Very few products have a life of 40 years. This is among the longest continuous runs of an HP product.

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[37 Web site slide with email address]

I am always glad to hear from anyone about HP and to answer whatever questions so feel free to contact me anytime. I am constantly expanding my web site so check back often for the latest information. A copy of this presentation complete with all the pictures will be posted on my web site as soon as I return to Birmingham. I am also giving a CD with a copy of the presentation to Don for your club archives.

I extend an open invitation to anyone for a private tour of my collection if you are ever in the Birmingham, Alabama area. Again, thank you for letting me speak to you. This has been a great honor and privilege that I have thoroughly enjoyed. I will remember this day all my life.