Oral History of Gary Gordon

Interviewed by:
Gunter Steinbach

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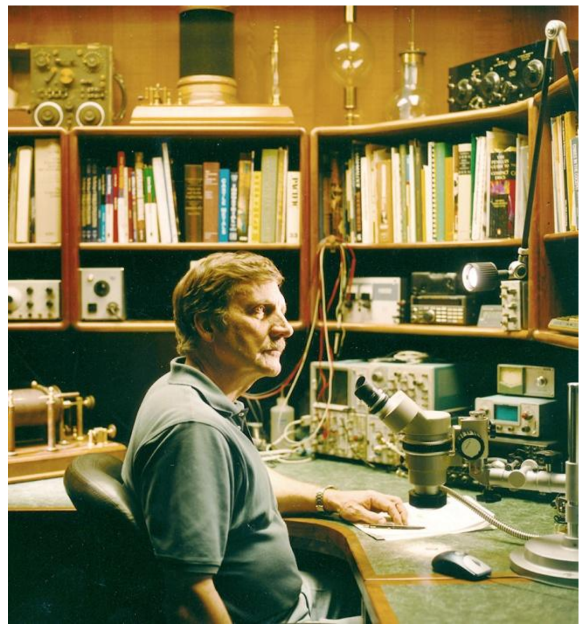
Steinbach: Okay, for the record, today is March first, 2017. I'm Günter Steinbach interviewing Gary Gordon in what I would call his natural environment, that is, sitting at his work bench <laughs>. Thank you, Gary, for agreeing to let me interview you.

Gordon: Thank you. My pleasure.

Steinbach: And I originally contacted you because one of your 79 patents describes the modern optical mouse for the first time, but we will not limit ourselves to that. We want to cover your whole life and career, and as you can tell from the number of patents, and your work having been featured on over twenty magazine and journal covers, that there's a lot more that you've done in your 38 years at HP. So let's start with the beginning.



Gordon: Thank you for the nice introduction.

Steinbach: <laughs> What's your family background? Where'd you grow up, and how did you get into electricity and engineering?

Gordon: I was born in Portland, Oregon in 1939 but spent my younger years in Spokane Washington. I think that around the age of six or seven, I became interested in taking things apart. I had a collection of motors, induction coils, fans, and buzzers, and really enjoyed figuring out how they worked, and generally, that amounted to taking them apart, and that was where they ended up. In parts. My dad had an electric train, which I didn't find interesting watching it go around in a circle, so I would go back to my corner and play with my toys.

Steinbach: So then you moved to Spokane.

Gordon: Actually what I've talked about so far was in Spokane. At the age of 10, we moved to Milwaukie, which is on the outskirts of Portland, and that's when my building really started. I had my own room off of the garage, which was away from the family and all its distractions, where, like my friends, I would just build things. I built two Tesla coils, an oscilloscope; I ground a mirror for an eight-inch telescope, and thrived on creating things, mostly mechanical, and eventually I got into ham radio.

Steinbach: Okay. So tell us about ham radio.

Gordon: Well, that was a cool hobby back then. It was a time when it cost a dollar a minute to talk across the country on the telephone. We could, using equipment we built ourselves, talk around the world for free, and we could have radios in our cars, so it was quite a neat hobby. This is a picture of my station, one of the few pictures of my childhood. I either built from a kit or from scratch almost everything in that picture.

Steinbach: Wow. It was always beyond my means, <laughs> ham radio. But anyway, you joke that you were raised by a principle of benign neglect. <laughs>

Gordon: <laughs> Yes, my parents were quite indifferent to all these technical pursuits, and so being left alone, I had to figure things out for myself. And I really appreciate that, because I think it led me to be sort of an inventive person, and I would recommend that as a good way to raise children.

Steinbach: So your family background was not actually engineering; that was something you started with.

Gordon: My dad was an accountant, my Mom stayed at home, and they had three children. That was a typical background for an engineer at the time.

Steinbach: Okay, so you said you knew you wanted to go into engineering, right? So where'd you go to school?

Gordon: Yes, it was pretty clear that I wanted to study electronics, and I applied to a number of colleges, and was also aware of the inevitability of having to serve in the military at some point. So I applied for a couple scholarships, and the one I got was the four-year Naval ROTC scholarship. My family would soon be moving to California, so I enrolled at the University of California at Berkeley and studied engineering.

Steinbach: So that was for an undergrad in Berkeley, and anything interesting from that time, like a summer job?

Gordon: I'd like to mention one summer job. I really wanted to work at Hewlett-Packard, and after a couple of visits I visited, and asked them how my application was coming along. The personnel manager was a lady I'll never forget, who said, well, "I've given the engineering manager about a hundred resumes, and they just sit on his desk. I think I'm going to say that you're the choice unless he has some objection" <laughs>. I worked on sampling oscilloscopes and just loved it. I would do basically technician work; whatever they had in mind. Toward the end of the summer, they were running out of things for me to do, and they said I could build a hi-fi set or an amplifier or something, or work on one particular problem with the sampling oscilloscope. The problem was when one changed the sweep rate of a sampling oscilloscope, the baseline jumped around, which was very embarrassing. It was known that the problem was related to the sampling diodes, and that different diodes would offset the trace by different amounts, and that the offset would happen at different sweep rates for different diodes. I decided that I needed a way to characterize different diodes. I decided that I needed a sweep generator, and the only way I knew how to do that was with a four-layer diode and a motor-driven potentiometer, which was really crude. Nonetheless I could change the sweep rate and see on the trace of the oscilloscope the point where the baseline jumped and the amount by which it jumped. Each diode was different, and I sorted them into a two-dimensional matrix using egg cartons, and I found that, if I took two diodes out of the same bin and put them in the probe, the problem largely went away. The lab director was extremely complimentary, and asked "Do you have an oscilloscope?" I said, well, 'course, a Heathkit three-inch scope, and he said, well, we can do better than that. So he walked me around the lab, I wasn't sure what he had in mind, and he asked an engineer, "Does this HP scope up on the top of your bench get used much?" The guy said no, and he gave it to me a wonderful going away present.

Steinbach: Awesome.

Gordon: So that was the main thing I remember from my college days.

Steinbach: Okay, and then what about after graduation?

Gordon: Well, I had to face the consequences of my Navy scholarship, and married my wife, Nicola Whitney, and unfortunately got sent off on a ship, as the radio officer on an aircraft carrier. Things improved after about two years when I was assigned shore duty at Treasure Island, a top-secret facility where they tracked Russian submarines in the Pacific Ocean. They used hydrophone arrays up and down the coast and in Alaska and Hawaii, and the information from these arrays would get collected and sent to Treasure Island and punched into IBM Hollerith cards. And at that point they really didn't use the cards for anything. They also had an unused IBM 1401 computer, and sent me to the IBM school to learn how to do something useful with it. I decided to write code to organize the sounds they picked up, decide which ones were Russian submarines, and consolidate the data to make it easier to comprehend. And so that was actually fairly interesting to do.

Steinbach: That sounds like the Tom Clancy thrillers, right <laughs>?

Gordon: Sounds like what?

Steinbach: Like the Tom Clancy thrillers, “Hunt for Red October” and so on.

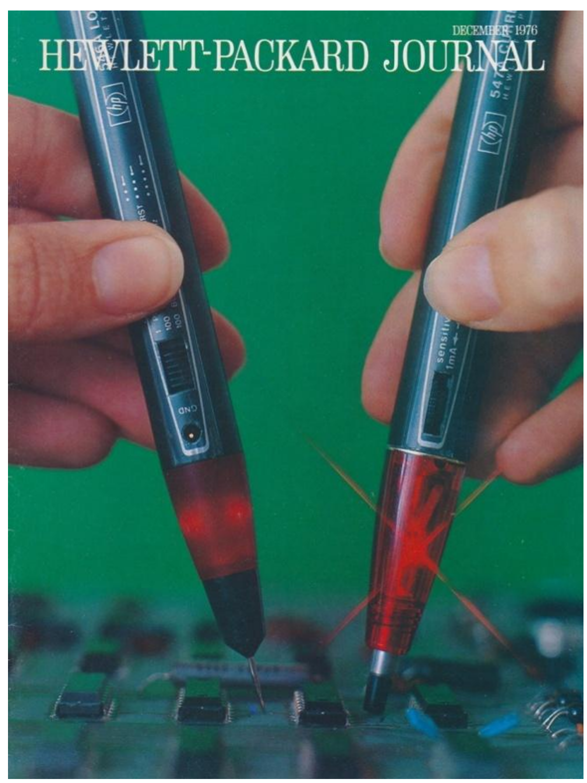
Gordon: Well, we did a lot of the things that Clancy later wrote about, tracking Russian submarines and playing dirty tricks.

Steinbach: <laughs> Okay, so you had to do four years in the Navy.

Gordon: Yes, and then when I got out, I was eager to work at Hewlett-Packard. Actually, while I was in the Navy, I would still build things. I had a workbench, and I wanted to show this. I’d taken some transistors and built some multivibrators <beeping noise> and made a key that would improve the way I could send Morse code, forming sequences of dots and dashes. And so to send code, you’d-- see if I can do this right. <beeping noises> So I took that to HP for my interview, and they said, well, it says here that based on your summer job results you’re pre-approved for hire, and we just need to decide which division you want to work in. So I chose a division called frequency and time which built frequency counters.

Steinbach: That was in Santa Clara?

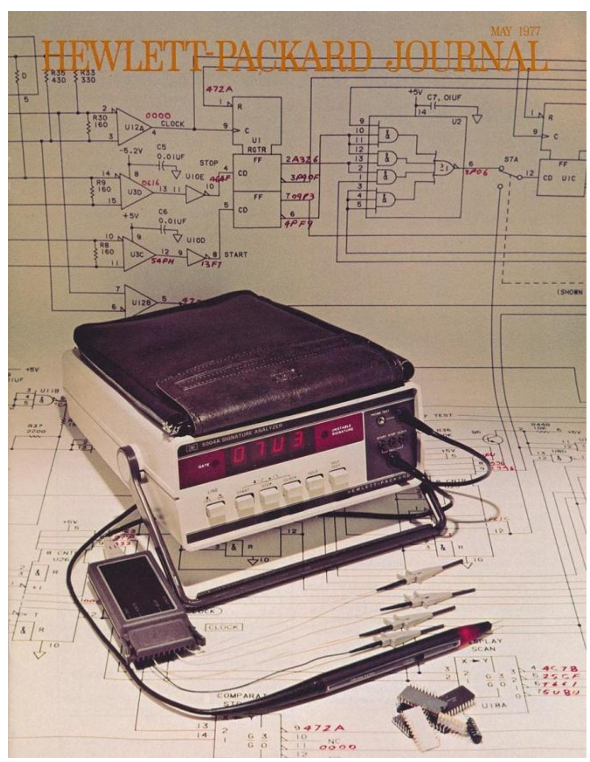
Gordon: That was the Santa Clara division. I was interested as I've said in radio and shortwave, and thought that counting frequency digitally rather than measuring it with analog instruments was quite an interesting concept. They asked me to work on an instrument called a computing counter. HP pretty much owned the counter market, and to grow it, they felt it could be useful to have computation associated with counting. An example would be, if you’re measuring the frequency of a slow-moving signal such as the line frequency, one could measure the period instead of the frequency, and convert that to frequency by taking its reciprocal. The arithmetic unit we built could process a twelve digit decimal mantissa with a two digit exponent. It could perform four function arithmetic as well as taking square roots. The computing counter was actually HP's first product that used integrated circuits. The IC's we used were known as SSI or small-scale integrated



circuits. A typical IC might have four flip flops in one package. Four bits was of course half a byte, and now we talk about terabytes.

Steinbach: What year was that?

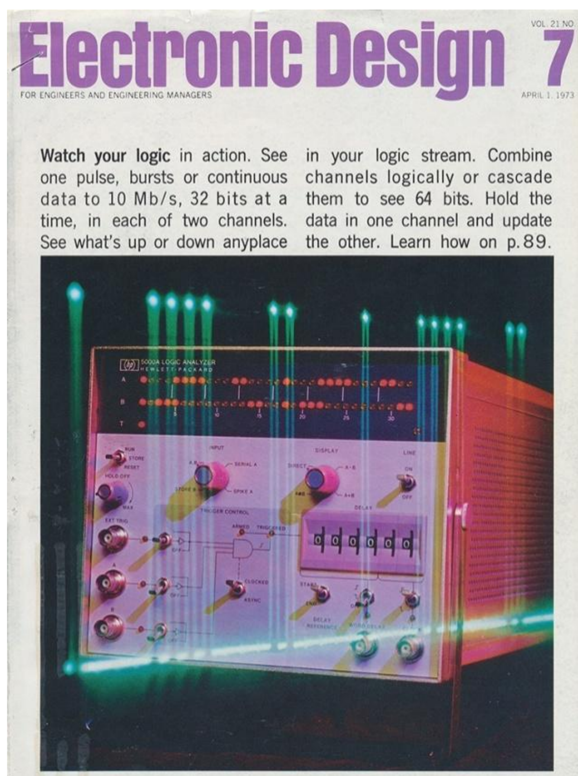
Gordon: It would have been 1966. One thing that was unusual about the project was that we had to develop new methods of instrumentation. Oscilloscopes, the backbone of analog testing, turned out to not be very useful. If you looked at digital waveforms with an oscilloscope all you saw was long bit streams that looked like square waves. So basically the scope was useless because all of the waveforms looked the same. As a result we evolved a system of testing we called single-stepping whereby we would clock the circuits one step at a time. At first we discovered that it was almost as useful to probe with a little light bulb on a wire to see logic states than with a scope, and with the light bulb one didn't need to turn their head away from what they were probing. I evolved that into the Logic Probe invention, which had a light at its tip, and showed states, bad levels, and positive and negative pulses. What I'm showing here is a demonstration of a typical small-scale integrated circuit, a four-bit counter. Probing this pin one can see the one-Hertz clock generator, and next this divide-by-two pin of the counter, and if you look at the divided-by-four pin, it doesn't change state as fast. And I thought, well, I'd really like to look at pulses also, because they're too narrow to see on the scope, and so I put stretchers in the Logic Probe, and I thought, well, I want to see both positive pulses and negative pulses, and I added circuitry in the Logic Probe to do that. So you have a negative pulse here, in my demo, coming from the clock of the circuit. It momentarily extinguishes the light in the probe, so that means that there's negative-going pulses on this pin, and a positive-going pulse would do the opposite; it would cause the light to flash. This got the attraction of the division manager, and he said, well, let's just see if we can sell these things, and so we put it in the catalog, and they sold like hotcakes. In fact, you can still buy them today, but they're mostly used by hobbyists. So we thought: What else could we measure? Well, one thing you'd like to do is to interject pulses into a circuit. So I won't demonstrate it, but that product was the Logic Pulser. And again, I wanted to be a little bit clever so that, if you put it on a pin that's high and pulse it, it drives the pin low, but if you put it on a pin that's low and pulse it, it drives the pin high. And that was a success, and then I was free-thinking what else could we measure. I thought, what about looking at all of the pins of an IC at the same time? HP had just come up with some of the first LEDs that had ever been built, and this was, again, before 1970, and so I thought, well, we can put these LEDs in a little clip-on device and clip it on top of the circuit and see the pins change state. And I always like to



do something a little bit out of the ordinary, so I didn't want to have to have wires from it to hook into five volts and ground, so I had it seek out the voltage and self-power. If you clip it on an IC upside-down, it doesn't really care which way it's put on; it works either way. So to continue on this, I wondered about digital service. I had remembered days of seeing schematics of things like television sets, and they would have little miniatures waveforms in the schematics on the transistors, and basically you'd do what was called signal tracing. You would trace the signal up to a point where the signals were good, and then on the other side of the device, if they were missing, you'd isolated the problem. So the problem with how to do that with digital circuits where the wave shapes all look the same on oscilloscopes. They're just meaningless, long streams of data. So I thought, well, let's do a checksum-- this is a CRC checksum-- hexadecimal that we can measure and write on the notes. So if you have good data coming into a device and bad data going out, then you've identified the faulty device. We called that product a signature analyzer.   And maybe I'll summarize the state of digital testing back then, which only lasted about 10 years. This was before computers and simulation, and it wasn't too long after that that you wouldn't have to fuss around with the single-stepping; instead one would simulate everything on a computer or use state machines or ROM arrays. And so basically, the first decade of digital design was single stepping, and looking at individual states with logic probes and the like.

Steinbach: And so basically, you got HP into that business of logic debug instruments.

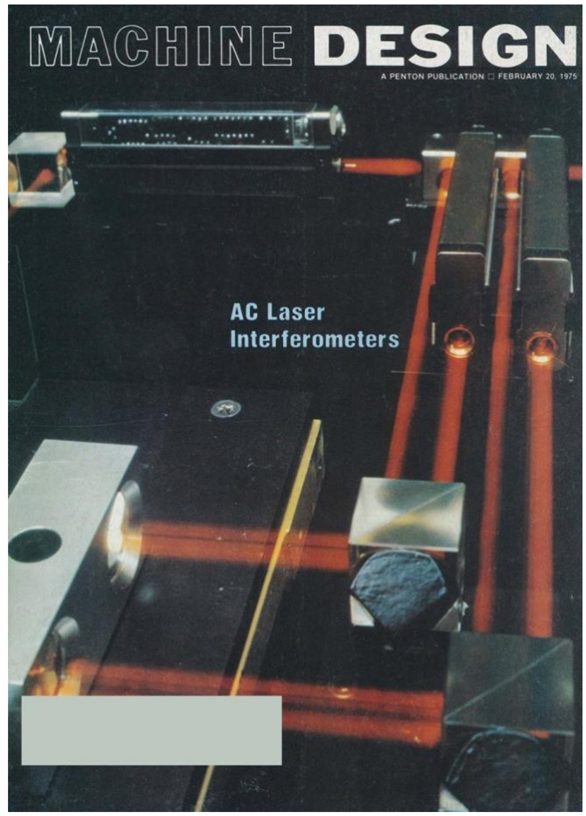
Gordon: I would say so, yes, and we patented these things and we gave them names. And so you might see something like a signature analyzer and wonder, what is that? Well, we tried to have the names be descriptive.



Steinbach: Okay, and the logic analyzer would be a similar instrument also with a screen.

Gordon: Yes, we realized that you could have a digital analogy to an oscilloscope and show the bits using light-emitting diodes, and that you could do a lot of other things, too. It could be a storage scope; it could also capture triggers. You could have data coming in and see the data that led up to a trigger, which was a lot simpler than the delay lines that you would have in oscilloscopes. Now, our 5000A Logic Analyzer started to get the attention of Colorado Springs division that made oscilloscopes. I wanted them to build a digitizing oscilloscope, but instead, they saw this, and they thought, no, we're going to build logic analyzers. My experience was with the HP-35 pocket calculator and serial computations, so we didn't have very many channels. The Colorado Springs Division was near the division that built a desktop calculator that uses 16-bit wide word. And so they built a wider 16 channel analyzer and pursued that line aggressively, and that was the right place to do it. And so course, you still see logic analyzers being made today.

Steinbach: Okay, so were you offered managing jobs in that area?



Gordon: Actually, the next project after that was a laser interferometer, and I did manage that project. Let me talk about that. It was a very interesting project, because it involved optics and mechanics; basically, we counted wavelengths of light to measure distance. And we built this instrument that would measure distance out to 200 feet to a resolution of a millionth of an inch. We're not the first people to introduce one; there were 10 other companies, but our main competitor was Perkin Elmer. And we had a really wonderful laser tube in ours that was designed by HP Labs, which was piezo-electrically stabilized, so it would stabilize in a second or two, whereas the Perkin Elmer laser was thermally stabilized and it took an hour and a half to warm up. So they would go into a customer and before a demonstration need to talk about something else for an hour and a half while their tube was warming up, where ours would just turn on instantly; you'd flip the power switch, and it was measuring distance. And we did several other cute things. All the competitors measured resolution to six millionths of an inch, which is a quarter wavelength of a helium neon laser. I added digital signal processing to ours that would interpolate to a millionth of an inch. So we could go into a customer, turn it on and immediately measure to six times the resolution. Basically, we just took over the market for that product. That was a lot of fun. That was one of my most favorite projects to work on.

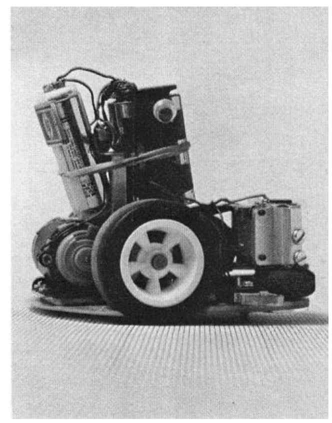
Steinbach: And nowadays, of course, they are still used in all the wafer steppers, right? These interferometers?

Gordon: Well, that's a good point. As ours stood, it would not work for wafer steppers, because it took 10 milliseconds to do the conversion from wavelength to English or metric units, and in the integrated circuit wafer stepping industry, you have to have feedback loops with practically no delay at all. So what they do is, instead of converting to microns and closing the feedback loop, they compute ahead of time how many wavelengths of light they need to go to a certain position, and then close the feedback loop in wavelengths. So basically, a lot of the features in this interferometer are not really necessary, so that was a simpler product, and I was kind of losing interest in that, so someone else at HP designed that product. But that's still a big market for HP, which has turned into Agilent and then Keysight, I guess. One of these companies to this day still makes these products.

Steinbach: Okay. And along the way, you also got a master's degree, right?

Gordon: Yeah, that was thanks to the Honors Cooperative Program at HP. They would send you to Stanford, give you time off and pay the tuition, so I very much appreciated that.

Steinbach: Okay, and you mentioned a mouse contest, which is not the optical mouse. <laughs>



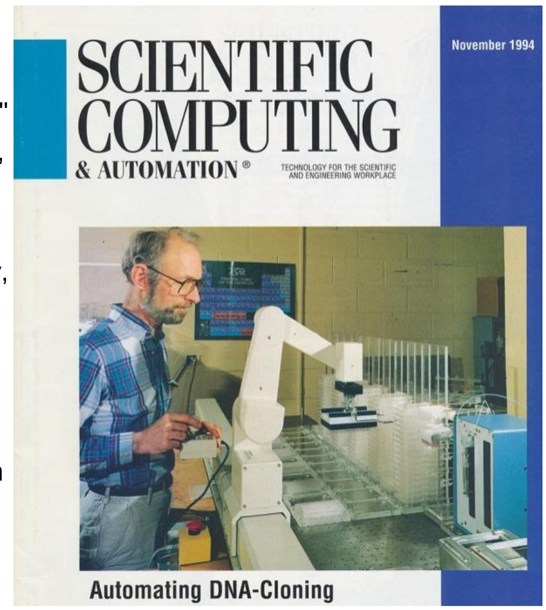
Gordon: Oh. Well, that's probably a little embarrassing for the IEEE. Microprocessors were just starting to come on the scene, and they had established a contest to build a microprocessor-navigated mouse that would go through a maze that they had built. And I read about that, I said to several guys I worked with, "You don't need a microprocessor to do that. If you follow the right wall, you'll eventually get out of this maze, and can probably do that pretty fast." They liked the idea and built the mouse. I didn't get too involved with it, but they took it down to LA and competed against a Battelle Institute mouse that actually used a microprocessor and lumbered around, eventually, I think, solving the maze, but our mouse solved it in a third the time. It would just basically keep banging against the right wall, and so I gave it the name-- there was a popular drink at the time called a Harvey Wallbanger--- so that was the obvious name for our mouse. And that got printed up in "Reader's Digest."

Steinbach: Cool.

Gordon: That's that story. <laughs>

Steinbach: Okay, and you went on eventually to end up at HP Labs.

Gordon: Well, HP had wanted me to be on a career path into higher management, and I think it was becoming evident to me and maybe to them as well that I'm really a designer; I really like solving problems. And so I went up to HP Laboratories, the central research laboratory, where they wanted me to work in analytical chemistry instrumentation, which I thought, oh, well, I'll do whatever they want. And I did that for 25 years, making parts of a string of very successful instruments that would look for environmental contaminants, identify DNA fragments, and so forth. It was fairly interesting, quite a bit different than the things I'd done. I can mention two of the projects. One I helped with was an instrument called capillary electrophoresis, and it would look at environmental contaminants, for example, and separate them in a long capillary tube; the inside diameter of the capillary was about the diameter of a human hair. Each chemical that was separated would come out of that capillary tube, and be identified by its color in the ultraviolet spectrum. The problem was that the absorbance path length was really short, maybe 50 microns, the diameter of the separations column. So I remembered as a kid, having a chemistry set that I didn't particularly enjoy, but I found it fun to take glass tubing and heat it over an alcohol lamp and blow bubbles in it. I tried that on these capillaries, where it worked really well, and it turned out that competing instrument manufacturers would buy those patented capillaries from HP/Agilent using the "bubble cell" as I called it. I'm skipping over a number of other projects, but another one I'd like to mention was a robot. It turned out that a lot of chemists were doing very boring work by repetitively analyzing thousands of samples the same way, so it seemed something that could be automated, and so we built the Orca Robot. And one thing I enjoyed about that was-- I think I'll mention just one thing here. We wanted to use a game teach box to teach the robot how to move, and so obviously, if you want to move the robot arm out, you'd push the stick forward. And to move it left to right, of course you'd move the stick left and right. But how would you lift the arm up and down? Well, I decided to put gravity sensors in the teach box so that when you tilt it up like this, it changed what the stick does. Left and right work the same, but the old in and out now becomes up and down. Somebody would inevitably ask, what if you hold it upside down? Well, it still worked; the gravity sensor just reversed left and right. <laughs>



Steinbach: <laughs> That's cool; that's very intuitive then. You just turn it so the stick does the right thing, right?

Gordon: Yes, it added more degrees of freedom to a stick that only had two, X and Y.

Steinbach: All right. So you did some electronics still even in the chemical analysis side--

Gordon: Yes, less and less. <laughs>

Steinbach: But not exclusively. It's a huge change in your career, right, from electrical engineering?

Gordon: Yes. As I'll tell you later, I still did electronics as a hobby.

Steinbach: And then you mentioned DNA, which has generally-- was that after the chemical analysis you went onto the DNA arrays?

Gordon: It was all in the same department, and fairly interesting; they would attach fragments of DNA on an array and then put a sample on top of it and see where the sample hybridized to the array, so they could identify DNA using this technique. And so I built some techniques for increasing the sensitivity of that process, which was just one of the many things that kept me interested in analytical chemistry and bioengineering. I designed a centrifuge that could change the force angle on a fluid being manipulated, and be able to agitate tiny amounts of a sample without the need for dilution.

Steinbach: About what time was that?

Gordon: 20 years ago. <laughs> Rather turn of the century, I guess.

Steinbach: Okay, so that's also the time when HP split off Agilent, right?

Gordon: Yes.

Steinbach: So then as I know, since I was there, too, you moved to Agilent; you moved along with Agilent, to Agilent, right?

Gordon: Yes, and only thing that changed was the name.

Steinbach: Right. Well, we always thought we were the real HP. <laughs>

Gordon: Yes. <laughs>

Steinbach: Right.

Gordon: Do you want talk about the optical mouse? Because that was the next thing I worked on.

Steinbach: Okay. And at that time, were you already an Agilent fellow?

Gordon: Somewhere in there that happened, which I appreciated <laughs>.

Steinbach: Okay, which is as high as you can get--

Gordon: On their technical ladder.

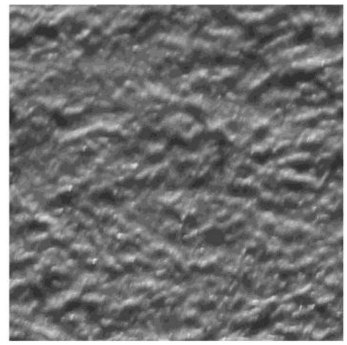
Steinbach: On the technical, yes.

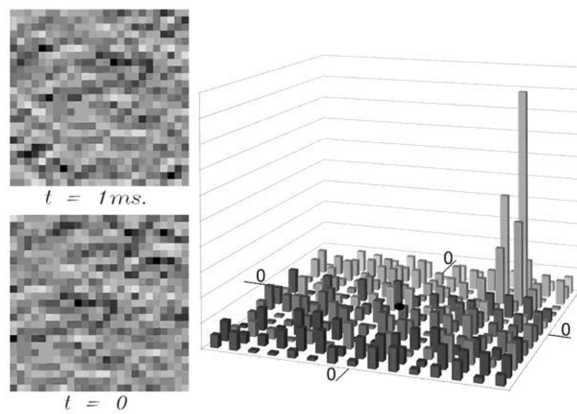
Gordon: Right. I had forgone the management ladder a long time ago.

Steinbach: Okay. Then yeah, let's talk about the optical mouse.

Gordon: Many years before I got really actively engaged in that, I used mechanical mice and was constantly aggravated. I brought one along to show on this video, because it's hard to still find a mechanical one, because they've all been thrown away, and maybe 20 years from now someone will wonder what the fuss was about. Well, they would get dirty, and their aggravated users would slam them on the table and blow into them and so forth, and finally take them apart. They were designed for easy disassembly, because it was something you really had to do <laughs> every couple of months: clean out the inside, blow it out, then put the thing back together. I used mine on a wood surface, and I thought for many years it should be optical, because I had seen target tracking in the Navy, I had studied correlation at Stanford, and there were projects around HP that actually-- there was a handheld scanner that determined its position by using optical scanning. So I thought if the whole world used wood desks I would make an optical mouse, but it wasn't the case-- my desk surface was Formica, and it looked really smooth, and so I was kind of discouraged. And it was a year and a half later that one time I was lamenting that I couldn't make an optical mouse that would work on the Formica surface. For some reason I scratched the Formica with my finger and could hear this vibrating sound, and realized that the surface was textured. And then I lit it obliquely with a flashlight, and under a magnifier, you could see all these hills and valleys. It looked like you were in an airplane flying at sunset over hilly terrain. And so I go, bingo, this would work. And so I want to give a short explanation of how optical mice work, because this is just about not written up anywhere, and I think it's worth covering. Optical mice image an area about two millimeters by two millimeters on the surface, so basically, it's a microscope and a crude image sensor having about 1,000 pixels. So if you look through a microscope at a two-millimeter square of paper, which I decided to use here as an example, it just looks featureless, but if you edge illuminate it at about a 10-degree angle and then increase the contrast, which you can do, suddenly you start to see all sorts of detail on the same two-millimeter square. We image that onto our sensor, which, again, is only 1,000 pixels, so it's a fairly crude image, but there's actually a lot of information buried in this. So what we do is take pictures every thousandth of a second as the mouse is moved, and then we slide the two pictures over each other to find the fit. So in this example, the same picture I showed last shows the image taken a millisecond later, and you can see that there is sort of a feature here that tended to move about six pixels.

So what we do is slide these two images over each other-- it's called correlation-- and look for the fit. As we slide them over-- we don't cover the whole array; we move maybe 5 pixels in every direction. So we test the "match" at about 100 different displacements. We compute the correlation coefficient at each of the 100 positions and keep track of them, and then at one position, you'll see a very strong correlation. In the 2D histogram I'm showing, we see what we expected; the mouse had been moved about six pixels on the diagonal. One pixel here corresponded to about three thousandths of an inch of mouse movement, and it turns out actually for CAD work, you nudge the mouse and sometimes want to move it maybe one thousandth of an inch resolution. So what we do is we interpolate between correlations, and say, well, it wasn't quite six pixels; it was maybe five point seven pixels on the diagonal. The resolution is typically ten times finer than for mechanical mice, which only resolved .0025".





Steinbach: And that works even if the mouse twists a little as you're moving, because that tends to change the shape, right?

Gordon: I think in a thousandth of a second, it doesn't twist too much. I'd also had an idea for what I called a flying mouse. I thought at one point that the television set and the computer were going to converge, and I was not correct on that, but I felt that if that happens, you're going to need a mouse to control the cursor on the TV screen. And so we built a flying mouse that would basically image the room, and correlate successive images. As you pointed it, it would watch that image fly around and tell you the attitude of the mouse. And we had a very brilliant manager in the components group, Jason Hartlove, who tried to market that to the Japanese, and there was a lot of interest in that, but that was about the same time we were coming up with this mouse thing. His thinking was headed in the same direction, so we started a frantic effort to build this mouse. I wrote a draft of a patent application at that point and submitted it, and it was allowed, but we put all of our names on it, of course. And basically, the optical mouse obsoleted the mechanical mouse in a matter of several years.

Steinbach: But the start of the idea was a mouse on the table, not the flying mouse, or what do you recall?

Gordon: It was the flying mouse, but all these things float around in your head as I told you: military tracking, correlation theory at Stanford, these other projects looking at optical navigation. And sometime I think in your head these things just kind of come together, and you realize that you should've thought of this years ahead of time. I kick myself for that.

Steinbach: Well, it wasn't too late, right? <laughs>

Gordon: No.

Steinbach: Nobody else beat you to it.

Gordon: They've sold about a billion of 'em.

Steinbach: Yeah, so what year was that that you wrote the patent?

Gordon: I don't remember years very well. Maybe 2000. <laughs>

Steinbach: Okay, well, it'll be on the patent, I guess.

Gordon: I might mention that I kept working on mice for a while, and one thing was we could make the sensor so small that I felt that we should be able to put it in a pin or some other device and maybe have better ergonomics with the mouse, but that didn't really catch on. But one thing that did was there was a lot of interest in wireless mice and the power consumption of the batteries that they had to carry, and the main power consuming device was the LED flashing a thousand times a second. And you had to flash it that often, because if you didn't flash every thousandth of a second, the mouse would move so far that you would have an image that could not be correlated with anything. So I reasoned that we could take a mouse reading and a thousandth of a second later take another image, correlate the two, and then we don't need to immediately start taking more readings. We can send information to the computer; we can extrapolate that and say, well, the mouse is moving in this direction, and we can just extrapolate where it would be and then a hundredth of a second later take another pair of readings. So we're cutting the LED power by a factor of five, and that amounted to almost extending the battery life by a factor of nearly five. So that got used; I think it's probably used in all wireless mice.

Steinbach: Did you patent that?

Gordon: Come to think of it, I think what eventually got patented was the variation where power was saved by continually adjusting the flash rate depending on how fast the mouse was moved.

Steinbach: Okay. Well, and obviously, the extrapolating version wouldn't be used if it wasn't reliable enough, right, for-- I guess your arm is pretty heavy, so the momentum just makes it a smooth movement.

Gordon: Yes, in a hundredth of a second, not too much happens. And it was a very smart engineer in the division, Mike Brosnan, who reduced it to practice, whose name is also on the patent, because one can come up with these ideas, but somebody else might-- I knew it would work, but he actually reduced it to practice.

Steinbach: Okay, and at one point, you mentioned fingerprint sensors.

Gordon: Well, we realized we could have a tiny sensor in a cell phone or a camera that would sense the fingerprints as they slid across it, and these things worked. I had another idea for adding momentum to a cursor on a screen to where you move it, the cursor keeps going along with its own-- that would be used with a touch screen, but these didn't get commercialized.

Steinbach: Well, the fingerprint sensor now is in the iPhone, but it's not optical. <laughs>

Gordon: <laughs> Okay.

Steinbach: Right? I believe it's capacitive.

Gordon: Mm-hmm. Their idea was much better because it was thinner.

Steinbach: Which is kind of amazing, because it needs to be very high resolution. Okay, so that was... kind of getting close to retirement? Were you eager to retire, or would you have gone on?

Gordon: Well, something else happened. <laughs> Actually, I quit; I didn't retire.

Steinbach: Okay. And so now--

Gordon: You want to know--

Steinbach: You've been retired for quite a while.

Gordon: Do you want to know why I quit?

Steinbach: Go ahead if you-- <laughs>

Gordon: <laughs> Well, I hadn't had a raise in five years, and I went to them and I asked for a raise, and I didn't get one, or a bonus. They said, well, the feeling of Agilent top management is that inventions happen by chance and that it's "times at bat"-- these are their words-- and if enough engineers swing the bat enough times, someone will hit one over the fence.

Steinbach: So it's all random?

Gordon: Yes, so I decided I'm old enough to quit; I think it's time to quit. So I still wanted to make some retirement money, and did a startup with two other guys. We started Cambotics, which automated network TV studios, and this is a picture of one of them, in San Diego. We made these robots that would carry these heavy cameras around the floor of the studio, under computer control, so a director could send different cameras to different shots, and they would scoot across the floor and set up the shot. We were profitable in the second year. I was the VP of engineering, and had completed the main designs, so there wasn't a whole lot more to do, and I sold out my interest and retired for a second time.

Steinbach: So what have you been doing since? But wait, didn't you get an award for that also?

Gordon: For what?

Steinbach: For the camera thing?

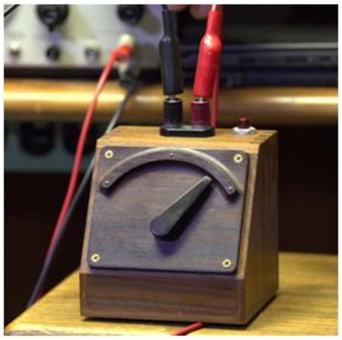
Gordon: No. <laughs>

Steinbach: No? Okay. I misremembered then. Sorry.

Gordon: So you were asking what then.

Steinbach: What you've done since then.

Gordon: Okay, well, I loved to keep building things. As I told you, this is my office; this is my workbench. I've always had a workbench. My wife Nicola and I designed the house to be supportive of our hobbies, and I also have a machine shop downstairs. One thing I did was --- I call it philanthropic engineering. I got involved with a group called Handy Hams that would teach people with disabilities, such as blindness and paralysis, to get into ham radio as a hobby that would get them out of their confined apartments and so forth. And that presented a lot of questions like: How do you teach a blind person the concept of a square wave or a sine wave or voltage? So enjoying building teaching aids; I made a Braille voltmeter that would read voltage, and you could connect a function generator into it and demonstrate a sine wave. The needle would go back and forth like this; nice sine waves. If you put a square wave in it, it would snap, snap, snap like that, something people could feel. I called it a Braille voltmeter. They could put their hands on it, feel this go back and forth and practice identifying wave shapes. I also designed a eye gaze tracker that would watch a paralyzed person's eyes with a camera, and use software to let them move the computer cursor and surf the web using their gaze. I also did a puff-and-sip telegraph key that would let them send Morse code with their mouth, and I produced a video about their HandiHam camp program. I still enjoy doing volunteer work.



Steinbach: So this was a summer camp kind of thing--

Gordon: Yes.

Steinbach: For kids and adults?

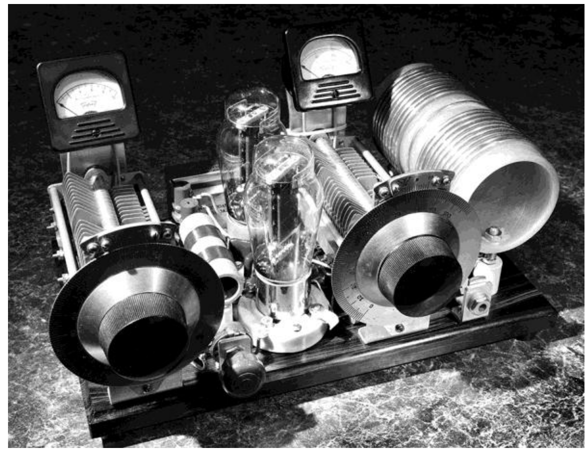
Gordon: Mm-hmm.

Steinbach: So you combined your ham radio with extra engineering for handicapped.

Gordon: Yes. I've gone on to building other things, like a second Tesla coil. I love photography, and did the shots for an artist's coffee table book.

Steinbach: Well, you keep yourself busy.

Gordon: One last example, I replicated several early radio transmitters such as the one up on the top of the shelf there. I wanted to study that one because it was one of the most popular transmitters in 1929, and yet if you looked at its schematic you'd say it couldn't possibly work. All the "explanations" might as well have added "as if by magic".



Steinbach: Did you write that up?

Gordon: I did, for the Journal of the Antique Wireless Association.

Steinbach: Okay.

Gordon: I enjoy writing, and I love engineering. The difference now is that I get to choose the projects. <laughs>

Steinbach: Very good. Okay, thank you very much, Gary.

Gordon: Thank you.

END OF THE INTERVIEW