Oral History of Doug Baney

Interviewed by:
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Steinbach: So for the record this is the oral history interview of Doug Baney, on August 23rd, 2017 at the Computer History Museum in Mountain View and my name is Gunter Steinbach. Welcome Doug.

Baney: Thank you.

Steinbach: And thank you very much for agreeing to this interview. My reason for contacting you was your involvement in the development of the laser mouse, but the interview is not just about that, it's your oral history including-- well, your life up to now. So let's start with the background. Where did you grow up, your siblings, hobbies?

Baney: I was born in New Jersey. My father was a Marine fighter pilot turned commercial aviator so he flew for United. And we moved to California because the weather is better at the airport there than Newark, New Jersey and so we moved out there in 1965. So I grew up for the most part in Northern California just north of [Santa Rosa] Santa Barbara, in the wine country up there. And I have a-- I was a family of five, was a middle child and my mother was a homemaker and also small business lady.

Steinbach: Okay, and how about did you start out early with electrical stuff or your hobbies or so?

Baney: Yeah, sort of. I think my first experience with electrical was with a rock band; I played bass guitar in a band.

Steinbach: So did I.

Baney: You did too? Okay, and I had a Sherwood amplifier, tube amplifier and it went dead and I was trying to figure out what went wrong-- what happened there. So I took off the tubes, dusted them off, put it together and it worked and I thought, "Well, maybe I know something about this field." And so, it started primarily with electronics with the band and also later in my high school I had a class in electrical-- electronics and so, that was a great opportunity to make PC boards and make my own little electronic counters and so forth because the 7400 series chips were coming out so I was able to do some things with that, so that was another experience. And then, my uncle in the Navy also supported me when I had some electronics that broke, Heathkit parts I couldn't figure it out, he'd send it off to the ship and they trained the technicians there on the stuff that I couldn't get working.

Steinbach: To fix your stuff? Very nice.

Baney: And then also, very important is, I was part of the special program in high school that we had, a mentorship with Hewlett Packard. So I used to bike up the hill in Santa Rosa and there a mentor would work with a team, we were about three people from the high school and we were working on the first microprocessors, how to program them in assembly language.

Steinbach: Wow, that's a very nice perk for being around here.

Baney: Yeah.

Steinbach: Very good, and you mentioned something about the vineyard getting you into actually studying electrical engineering and waves?

Baney: Yeah, the wave aspect. Yeah, the bass guitar string, of course, there's a lot of waves there, but the Vineyard, what fascinated me is I had a job where I pretty much ran the Vineyard off-season. So I did the tractoring. I ran the cables across the Vineyard and these are the cables that-- they're big, big, big spools you put on the tractor and then you tie it at one end of the post and then you run the tractor and the thing would spin and you'd lay out, you know, cable as you went. And you'd have to tack it up periodically with loose tack and then get to the other end of the vineyard. Well, the vineyard was probably almost-- not a quarter mile, but it was pretty long the distance that you would run these cables and I shook the cable just to see what it would do and I watched this pulse, this wave packet go down the vineyard, it hit one of the staples I had. Part of it reflected, part of it continued, I said, "Wow, this is great. I want to study waves." So I ended up going to Cal Poly at the recommendation of a Hewlett-Packard engineer and I was going to study microwaves because that was the closest I could get to waves. So that's how the Vineyard tied in with my future.

Steinbach: Wow, that's cool. Okay, so you mentioned the study, let's get your engineering degrees just up front, when and where you got your degrees?

Baney: The first degree was a bachelor's of science in electrical engineering. That was from Cal Poly in San Luis Obispo, beautiful place, lovely place near the ocean there. And that taught me a lot of practical things how to build things and electronic engineering behind it. Then I went back to work, which we'll probably talk about later. And then went to UC Santa Barbara right on the ocean there, beautiful. Studied microwaves, optics and acoustics and got my Master's degree there on a HP Fellowship. Then, went back to work again, resigned from Hewlett-Packard. A company called Serge [Serge was the CEO] Dassault-- it's a French aeronautical company-- offered to pay for my PhD in Paris. So I went off to France and then I got my PhD there in France.

Steinbach: Okay, what year was that?

Baney: That was in 1990. December 19th, 1990.

Steinbach: Okay. All right. So back to your working career, which, I guess, was mostly at Hewlett-Packard, right?

Baney: Yup, Hewlett-Packard, Agilent, Keysight.

Steinbach: Yes, that's right. Hewlett-Packard and what it turned into. So yes, start at the start. When did you become an employee actually?

Baney: I became an employee in 1977, I worked in the stockroom. It was a high school summer job and a…

Steinbach: So I was just going to say, you didn't really start at the-- from the stockroom to the CEO.

Baney: Yeah, no, not CEO, but yeah, I started in the stockroom where I learned how to pull parts from bins really quickly count them-- these little capacitors, little transistors parts-- and there I pushed a cart around and as fast as I could I went through this stack of IBM cards pulling out part numbers like 1800 – 0026 capacitor, count out 100 of those little grains, put them in a package and off it went to the production line and so I did that for the summer and that was a great experience because I learned a lot about electronic parts. Then I had an internship in 1980 in the microwave laboratory at the Santa Rosa division and there I worked on a new kind of transmission line called a suspended substrate transmission line, and it was designed to propagate waves at millimeter wave frequencies, you know like, U band, V band, W bands. So up to 110 gigahertz and so my job was to build these substrates. So I had to learn how to layout microcircuits and then characterize the dispersion and transmission properties, you know, of these microwave transmission lines and there I learned a lot about wave theory too in that summer job and that was in my third year at Cal Poly and then the fourth year I accepted a job offer from Hewlett-Packard, you know, I saw an offer-- back then you didn't look at the salary. It said offer, I said, yes. It was different then.

Steinbach: And this was at Santa Rosa then?

Baney: Yeah, Santa Rosa division.

Steinbach: And so you went into that microwave laboratory?

Baney: Yeah. So I had gotten an offer, but actually prior to that I got a phone call from a guy named Siegfried Linkwitz. He's a famous-- he's also known in the amateur sound community-- and my roommate who went to work for Tektronix said, "Hey Doug, Hewlett-Packard's online," I go, "Great, I got my offer," right? And I answer my phone, it was like 8 AM sharp --he was German obviously-- and he goes, "Doug, I'm from Hewlett-Packard I have some questions for you?" I go, "Oh, no." So he had the final interview over the phone and he was asking about the wave theory and waveguides and stuff like that, but I passed and then went to work full-time in the signal analysis division R&D lab as part of the millimeter wave group.

Steinbach: Okay. So what was your first product that you worked on or project?

Baney: First project we were working on U/V/W band mixers. That's basically a frequency range from 40 to 110 gigahertz. Military love this stuff. And so, the first project-- this is what part of it looked like, finally-- was a local oscillator multiplier. So we take a YIG oscillator, which operate from about 3 to 6 gigahertz and then, put into this and this would multiply the frequency up so when you mix it you had better conversion loss, more efficiency in the conversion from high frequencies to low frequencies. So my job was basically this box starting with the transformer I designed that, back when you did things like that. Then the power supplies that ALC loops, the control loops and then also the micro circuit, I designed that. It has this funny shape because it's also designed to go into a module and so, this was a combination of GaAs-FET devices, Sapphire, five mil Sapphire circuits, diplexers, amplifiers, programmable filters, everything is there. And then another amplifier which I designed is not shown here, but this was the hard part was this circuit right here and so, there'll be a blowup of that picture. I also designed a MMIC that went inside there, a gallium arsenide MMIC.

Steinbach: So that would have 100 gigahertz coming out of it?

Baney: So what would come out of this is up to about 20 gigahertz, 30 gigahertz-- 30 gigahertz and that would feed on a high-frequency cable off to the mixer and that mixer then would have an amplified high-frequency local oscillator and then it would only have to multiply it by four or something like that to get to 110 gigahertz. So that was my first project at Hewlett-Packard.

Steinbach: That's pretty comprehensive in terms of the span of technology.

Baney: And I learned a lot back then. For example, on the control loops and stuff like that; ground current effects and so forth, the slightest errors and you'd have hum and so forth. So it was a big learning experience for me.

Steinbach: And then, you said you got your master's while you were working at HP?

Baney: Yes.

Steinbach: Or did you take time off?

Baney: It was time off. So I got an HP Fellowship in 1985, went down to Santa Barbara and I was-- I think I was on three quarters salary, it was a really nice program and I stayed at Santa Barbara. They had a one- and a two-year program. The one year program you take like the PhD qualifying exams, kind of like that it's an oral exam and basically you go in and you take the exam at the end of your studies. Literally, there's three professors behind a desk that say, "Hello, Doug. Go to the chalk board," and from there on its mathematics all over the board and so, I got the master's there.

Steinbach: Okay, great. Did you ever consider just leaving to go to another employer?

Baney: That's a great question. That thought has come up, you know, I'd..

Steinbach: There were times when the natural impulse kind of..

Baney: Yeah, yeah. I had a great manager. One of the reasons why I hung around; it was a great company, a great manager. Steve Newton's a wonderful, wonderful person. However, there is the call of the valley and the startups and there were times where I had some pretty good offers that I'd turn down to work at-- one turned out to be a massive start-up and then another company that did very well, but I don't regret it. The experiences at Hewlett-Packard and Agilent have been wonderful, but there was a call to the start-up kind of like wolves howling in the distance, you know? "Join us."

Steinbach: Yes, I heard that call too. All right. So after the master's you went back to HP?

Baney: Mm-hmm.

Steinbach: And up to when you started to-- once you decided to do your PhD, right? Do you want to talk about what you worked in between that time, after the master's?

Baney: Sure. So at that time it was the very beginning of fiber-optic communications and the lasers which drive the fiber-optic communications which drives the Internet weren't well understood. There is a lot of work to do and understand these new kinds of very compact semiconductor lasers. So, of course, they needed tests, being Hewlett-Packard, we have to test it, right? So my job was exploring, basically, optical discriminators for discriminating the lasers when you modulate the intensity which is how ones and zeros are transmitted, you know, one's high power, zero's low-power and the first-- that's the way the communication systems work. Well, when you make a one what happens is that not only does the power level change, but the frequency changes and it's called chirp. So we were looking at characterizing frequency modulation under dynamic intensity modulation. So that project led me through a certain path to this device here. This is called an interferometer and this is a product that I worked on. Actually, I did pretty much the whole thing with mechanical engineers and what it does is it takes in an optical signal the laser feeds in, it goes into the interferometer, which basically compares the-- a version of itself with a delayed version and that delayed version could be like four microseconds later and then that output you analyze with an instrument. Well, it's kind of like understanding the change in a person if you look at yourself in the mirror today and you compared it to 10 years ago, seeing how much you changed. Interferometers kind of that way, it's a way of looking at the change in the laser. I had a polarization controller, which the first one failed. We put it on a robot and when we tested it by hand it worked great, but we put it on a robot and after 50 cycles the bearings seized up and it ripped off the knob and-- anyway so we learned a lot about robotics at that time, but that was the first-- well, between the masters and the PhD this was the box and this was the box that made me go to get a PhD. Because inside this box in the detection system, the laser would go in and the quantum phase fluctuations on the laser manifested itself in the interferometer in ways I didn't understand. So I said, "Well I have to get more education to understand really what's going on here." So that drove me to get a PhD, was this product-- learn more about how it operated.

Steinbach: So you decided to get a PhD and this time not on-- or HP did not offer to help you?

Baney: They didn't. They didn't because I resigned, but..

Steinbach: Oh, so you just decided to go off and do this.

Baney: They paid for my master's, I wasn't going to ask for money again. And so I just resigned saying "I finished the project and now's a good time to go get a PhD."

Steinbach: Okay.

Baney: So I resigned and what happened was before I left they said, "Well, what if we payed you half time, would you stay with us?" And I said, "Yes, of course." And so I ended up staying with Hewlett-Packard. So I went off to France.

Steinbach: And-- oh, yeah. You mentioned that you had the offer of the PhD program actually being sponsored by Dassault?

Baney: Yeah, Dassault. Yeah.

Steinbach: How did they hear of you?

Baney: My PhD Professor, Philippe Gallion was-- is fairly well connected in France and so, typically a professor looks for money so he said, "I have some money from Dassault." So yeah.

Steinbach: All right, I remember you telling me that like me you met your wife in-- abroad?

Baney: Yes, I did. It's kind of strange how life takes you on these paths. You know, what got me to France was the fact that my master's degree was—partly, it was in the US and I wanted to go to Australia, but UCSB was a great choice, I said, "Well, PhD will be somewhere out of country," at least one experience out of country. So I came across a journal, it was called, "Journal of Quantum Electronics," there was an article written by a professor in France and I thought, "Well, this guy," it was related to the work I was doing with the interferometer and I thought, "This guy knows what he's doing." He did experiments so he's not just theoretician, but he could go cross domain. So I'm going to go study in France. So I went in, in France and I was dealing with the French authorities on the permit to stay in France, which is extremely laborious, the work I had to go through with the paperwork. Even my professor came to the police station once, arranged for a seven-- no, it was an 8:00 AM rendezvous with the police in the 19th Arrondissement. Went up there and it was an 8:00 AM appointment and I knocked on the door and there is a line of 1000 students long and they say, "Well, we don't open until nine," and I just saw a little door opened up, I saw his nose and they said, "Go away." And at the front of the line was my future wife, I didn't know at the time, but Barbara Rogowska now Basia Baney. I met her there and showed her my little what's called a convocation. It was a little note showing that I needed to go to the interview at eight. She said, "Yeah, yeah," so I wait at the front line. I met her there and I was in the police station as the French police were trying to pick up on her, I dropped my business card off, I said, "I'm new in France, give me a call," you know, we'd meet up so it started from there.

Steinbach: Cool. So this was early on in your stay?

Baney: Yeah, yeah. Right towards the beginning.

Steinbach: I met my wife on my second day here.

Baney: Oh. <laughter>

Steinbach: Anyway. So, yeah, what was your PhD work about?

Baney: The PhD was about modeling lasers under dynamic modulation. So these are injection current lasers. You can drive them with a current. They're very compact so they can be really cheap, they're multi-section, which was a new kind of laser that allowed you to adjust the gain of the laser, the phase of the laser and the frequency of the laser independently, but it turns out when you modulate the laser it creates a lot of that changes in frequency I mentioned earlier and so forth. And so, my objective was to understand, theoretically and also experimentally, how these lasers were performing. So it was an extension of my interest at Hewlett-Packard.

Steinbach: Okay, and-- all right. So what year did you get the PhD?

Baney: 1990.

Steinbach: 90, right. Sorry, you told me.

Baney: December 19th, 1990.

Steinbach: After which, you returned to HP, right?

Baney: Yes, I flew out of Charles DeGaulle with Basia, my wife.

Steinbach: You married her during your PhD?

Baney: Yes, we got married in Poland. In a small town called Mozdzenie [wedding was in Wasosz, reception was in Mozdzenie] in northeast Poland and had a great wedding there. We invited the whole town, there's nine houses in the town. It was a farming community. We had the reception in a barn and the marriage was in a 15th century church, a very old church. And so we got married and then came back, flew-- well, six months-- let's see we got married in June, came back in January 1991 and that was during the bombing of Iraq so the airports were empty, planes were empty. So and started work at Hewlett-Packard laboratories.

Steinbach: Okay, so that was at the Labs in Palo Alto then?

Baney: Yeah, yeah. Yeah, they had offered a job at Santa Rosa and also the Labs and they said the Labs might be more interesting for me, you know, with the PhD and the kind of work that was available. Yeah.

Steinbach: So now then we come to the projects you worked on at the Labs?

Baney: Mm-hmm.

Steinbach: Tell us about it?

Baney: Okay, I started out building reflectometers. Those are optical circuits basically. It seemed like at the time everyone who joined the Labs in the optical department had to build an interferometer so I built my interferometer for reasons-- working with the likes of Wayne Sorin, very, very smart guy. We developed reflectometers that could measure minute reflections in optical fibers or optical systems, down to an optical resolution of the order of 30 microns or so. And we developed this to go out to hundreds of meters and so. It was a way of characterizing fiber, fiber-optic components. Later, that work-- there is a new kind of fiber that came out, it's called a Heavy Metal ZBLAN fluoride fiber. You could propagate light down it and that fiber had active material in it, it had rare earths doped in it and I started exploring making lasers from that. So we developed the first diode pumped blue laser in a ZBLAN fiber. Actually, the world's first orange laser, you know, there's actually an orange laser and fiber diode-pumped was done by that and that was an accident. I was actually trying for a different color, but it came out orange, so that was good enough.

Steinbach: It's worth a paper, I assume?

Baney: Yeah, there was a paper, so we published on the praseodymium up-conversion laser. The up-conversion process is kind of like a ladder. You have to get to higher energies from lower energy pumps. It's like a ladder. You have one laser that pumps you up to a certain level. The next laser brings you up the ladder again, and then the higher up the ladder, the more energy, so you go with shorter wavelength photons, which are higher energy, and you get blue light and you design a laser cavity out of that.

Steinbach: Okay.

Baney: And so I used, initially, liquid nitrogen to cool the laser down to study at. It was really cool. You know, the vapor is coming off the table and the laser is glowing blue. So I later worked with Bill Chang on nonreciprocal devices. These are optical isolators and circulators. We produced some really interesting work there and developed noise figure methods for the new optical amplifiers that run the Internet, and so we developed the noise figure theory and measurements, and a lot of measurements are still used today to measure amplifiers globally. So that was another project that I have worked on at Labs. Labs was a great environment for exploration.

Steinbach: Yes, I know. All right, and eventually came the laser mouse, right?

Baney: Yes.

Steinbach: Which is a pretty big step from up-conversion lasers and interferometers into consumer-grade things, which have their very own-- very different constraints and conditions. So what made you do that jump?

Baney: Yeah, the jump to the laser mouse?

Steinbach: Yes.

Baney: A little bit of serendipity. So I had two-- I was managing two groups as a project manager. One was a telecommunications group where we looked at packaging optical devices. Another was a photonics group where we're looking at instruments. And so on the telecom group, we're doing work with electroholographic crystals which we turned into add/drop multiplexers which could steer light around circuits. Well, the telecom crash came, right? 2001/2002, 90 percent of the industry lost their jobs, so it was a very serious time. We were cutting back also at Agilent. So, it came a time when I had to focus the group, the telecom group, away from telecom because we were all going to lose our jobs. So we better find something else to do. So it came down to exploring two areas. One was non-contact PC board tests, so rather than probing down on the circuit, you do it remotely. And the other, there was a need for optical mice because overseas they were producing knockoffs of our current LED mouse. Because of that, we needed new technology, so the division we were working with at the time called SSD said “we need help in optical mice.” So I thought, "Well, we could potentially explore that." We didn't have any good ideas. Or we could do PC board test, and I remember one day, Waguih Ishak came up to me and said, "Well, Doug, what are you going to do?" I only had 20 percent of the information I needed to make a decision, right? PC board, which we weren't sure what we could do exactly there. I had some potential ideas for the mouse, potential ideas. You know, we had ideas of maybe using strings to move it around, all sorts of ideas. And I said, Oh, Waguih, we're going to do laser-- well, no, actually I didn't know it was laser at the time, we're going to look at mice.

Steinbach: Okay, so it wasn’t a laser?

Baney: It was not a laser. I didn't say we're going to look at the laser mouse. We're going to look at mice. So I had these brainstorm sessions, and I took the smartest-- all the Labs is really smart people, but I took the people in my group, from the telecom group, and my photonic systems groups and I had a series of brainstorm sessions. One Brainstorm was on the PC board mice-- on PC board test and the other was on the mice. And so ideas came up, but there wasn't any clear winner. It wasn't obvious what approach to take, so anyway, I told Waguih, "Well, we'll go with the mouse." And some of the ideas involved literally a laptop computer with, like, a string coming out. You know, using strings and stuff, so it was all over the map, these brainstorm sessions. So folks like Tong Xie, Mark Depue, Ian McAlexander, Greg VanWiggeren and Bogdan Szafraniec, all PhD level researchers are contributing to these brainstorms that I held. And so we came down to the choice, the decision, to go with a mouse, look at the mouse. So I posted a big sign on the door that said, "Can we build a better mouse?" As opposed to mousetrap, and we got to work on some of the ideas we had. That evolved where it looked like we had an innovation that looked like it was going to work really well. And that was actually, rather than the optical mouse, which is an LED and kind of looks at shadows. We're going to look at surface shape. And so we developed a technology to look at surface shape and it was called "Quattro." And so I focused down to a core team, Tong Xie, Mark Depue. Greg VanWiggeren and Ian McAlexander helped as well. I had Ian look at laser safety, because with this new idea of surface profile, there's a laser involved. And so the laser that we..

Steinbach: Why does it take a laser?

Baney: Oh, the spatial quality of the beam. The beam is very high-quality and you need that kind of quality to measure fine shapes and surface detail. And so Ian was looking at eye safety issues and learned, you know, Class 1, Class 2, Class 3, you know, what lasers to have. The current laser we had was a Sanyo laser. It was a buried heterostructure laser that produced red light, and that was used in our first brick. It's kind of like this clear, plastic brick that we used for the first demonstration. Later I thought, well, given the evolution of the VCSELs, vertical-cavity [surface-emitting] lasers, and the way you can produce these in wafers I said, "Team, we're going to use VCSEL lasers," and so we focused on that. So with the larger team then, I boiled it down to a small core team of Tong Xie and Mark Depue. I was the manager. It was a very close-knit operation, and we had a horse, which was our mascot. It's in the picture. So with that core team, we had some successes. A lot of people wanted to join the project from outside the photonics group and unfortunately [for the people who wanted to join] I wanted to keep the team very small because it was a very efficient team and so with the genius of Tong Xie and Marc we started producing these mice, laser-based mice.

Steinbach: Now, did you stick with infrared, or did you go to a visible light? I would think visible is kind of preferable, I mean for-- maybe not for the technology but for people.

Baney: The first laser was a red laser. It was visible, but it turns out that-- this is the optics here and that's-- you can see the leads of the VCSEL right here. VCSELs are really cheap and they're operating at 850 nanometers and so cost was everything with the mouse, so by going with these VCSELs, which were currently produced by Agilent at the time, we could have very, very low-cost sources for the illumination on it that was used. So-- and I liked the spatial mode. The mode shape of the VCSEL is a very high-quality shape, which was necessary.

Steinbach: Okay, so I guess you don't have to see it if it's low enough power that it doesn't hurt your eye, right?

Baney: And you can always put a 20-cent LED in there if you had to, right, to make it glow, right, which they do.

Steinbach: Well, that's an extra 20 cents. Okay, so you didn't do much technical work on that, but you guided your team, I assume.

Baney: Yeah, the technical work mostly for me was the general direction that we had to go, constant-- as every manager should do, a technical manager-- you flood your team with ideas and you have them help sort through, so the push for me was the VCSEL, the choice of laser. Tong Xi did a lot of the optics, so did Mark Depue. So my technical aspects are mostly on the laser side.

Steinbach: Okay, and so you mentioned you look at the shape of the surface. That means you still have an imager? I mean you look at an image?

Baney: Yes, yes. So the previous mouse was based on LED and it used an imager and that was actually also invented by labs, the folks in Labs, as you know, and so we took the next step which is to look at the surface shape instead of the shadow in there but we used the same imager and that was great because we were trying to get parts for the project. Now, where do you get parts? Well, Penang is far away. It's tough to get parts in a high-volume stream, so we went down to Fry's and we'd buy laser-- LED mice...

Steinbach: You were buying mice.

Baney: ...rip them apart, and then use the parts. So in the picture there is an actual LED-based mouse there, but we're using laser illumination to measure the whiteboard material that we're looking at. So the previous LED mouse is-- it's kind of like they say, as you move forward in technology you're always standing on the shoulders of other people and projects and so this stood on the LED mouse.

Steinbach: Okay, that is something that's new for me. I thought when I hear "laser" you would use speckle or interference or something like that, right?

Baney: We looked at all that, interference for surface profile. We looked at speckle, stayed away from that, ended up looking at specular, which is kind of like when you walk down the hallway the sheen you see off the floor is specular as opposed to speckle.

Steinbach: Okay, so how long was-- were you and your group involved in this? Eventually, you hand it off to the manufacturing, right?

Baney: Yes, so we started around November 2002 and we started the brainstorming at that time and developed the Quattro mouse, the brick, which you can see in the picture. Then, we entered the Great American Mouse Bake Off, and so we were one of the entrants.

Steinbach: Who put that on?

Baney: Jack Wenstrand. Dr. Jack Wenstrand put it on. He was at the division. He says, "We need the best mouse," and so I think three or four different technologies entered, and ours was one of them.

Steinbach: Okay. Do you know what-- were they also Labs departments or in other divisions that-- do you...? If you remember, I don't know.

Baney: We were not allowed to know about the others. <laughs> I think one might have been from Labs somewhere else and then some were external technologies, but we knew nothing of them.

Steinbach: Oh, so he looked elsewhere, outside of the company.

Baney: Yeah, yeah, outside the company. So we entered the Great American Mouse Bake Off, we won, and then Jack sent me that note that said, "Doug, fasten your seatbelts," because it took off like a rocket. You had the large production of the LED mice, and I liken it to a train. Train's arriving in town. You better hop on it quick, and that's what we had to do. So working with the division, which was called SSD-- Roop Grewal he was a project manager there-- we started transferring the technology, which also meant transferring literally Tong and Mark DePue over to this for a period of time, and it took off quickly. The mechanical engineers got involved, developed the mock-ups from our original brick, and then by August 2004, I think, or November 2004, mass production worldwide.

Steinbach: So two years.

Baney: Yeah, less than two years.

Steinbach: At which point it was out of your hand. Or did they come back and said there's something not quite right?

Baney: Well, at the time also we had major organizational changes and literally things were pulled apart, but we got the mouse done and transferred over. So that-- like the first units, talk about the volumes. When you have [test] instruments like these, you think maybe 5 or 10, 100 a month would be great. 500 a month would be huge. The first units were like 50,000 units of these things, so it was a big production. So working with professionals like Jack Wenstrand and Roop, it was a beautiful transfer.

Steinbach: So how far did your group have to go in terms of doing those real deep-down trade-offs that you have to do for consumer product where the price is, I assume, almost everything?

Baney: Heavy. This is the first laser mouse, the MX1000. Part of the big trade-off, one is...

Steinbach: Is that a Logitech?

Baney: Logitech, yeah, so we transferred to Logitech, and the first thing is the laser, right? The other parts were mass quantities, the imager and so forth, so the selection of the laser, a lot of work went into that, Labs. We did that, the selection of the laser. Then, the optics and the imaging system we designed as well, and it had to be developed in very low-cost plastic. The traditional glass lenses, the spherical lenses that we use in telecommunications, could no longer be used, right? So it was huge. I can't tell you what the prices are because I'm not allowed to say, but cost was everything and then the timing was everything. We had to hit certain markets' windows and so time-- it had to go extremely fast, but it did and it also leveraged a lot of the parts that were in the LED mouse and of course Logitech is king at consumer, right, the computer accessories. So working with a great partner, we transferred it over and they packaged it up. We developed our own packages, but Logitech ultimately developed the shell and so forth and we were primarily the imaging system, the laser, and all that is what we provided.

Steinbach: Okay, so Logitech bought the engine, basically, from Agilent?

Baney: Yeah.

Steinbach: Okay, but Agilent-- but they didn't have, I assume, much control over the engine itself, right?

Baney: Logitech?

Steinbach: Yeah.

Baney: Logitech, as our end customer, they had a lot of control but we had developed the technology which they took. But certainly on the development side of the laser mouse, they were not involved in the development of the laser mouse but they were involved as our customer of our end product, if that makes sense.

Steinbach: Yeah, okay. All right, and is it other now knockoffs of the laser mouse?

Baney: I'm sure there are. I haven't looked at the market in a while.

Steinbach: But one would assume that somewhere in China they are knocking it off.

Baney: I'm sure there are knockoffs of it. Obviously, there is an array of patents that we had developed around this because it was really new ground, but I'm sure today there's knockoffs off it. But what had happened is after we had developed this project, transferred it to the division and so forth, we went through some huge organizational changes and my focus went away from the navigation. We did-- at the same time we were developing the laser mouse, we were also looking at other navigation schemes which we called triangle mouse. So I was working with Tong Xie exchanging ideas, and he designed the systems. It was basically a system that would do triangulation by scanning this surface with these laser beams, and they'd be moving back and forth, and actually we could then track objects. That didn't pan out, but this one did, so...

Steinbach: I think such systems they have now for virtual reality. I-- my friend showed me one where you have beacons in the corners and they scan and just the timing when it hits you tells them where you are, that kind of thing.

Baney: Yeah, yeah. This is done based on retroflectors and scanners, basically.

Steinbach: Okay, so-- oh, and Agilent produced the engines, the mouse engines and then they spun off the semiconductors, of course.

Baney: Yeah. We spun off. It went to Avago, and then after that I don't know where it went. <laughs> I'm not sure where it is today.

Steinbach: All right, so after the mouse what came next for you and your team?

Baney: Yeah. After the mouse was the dark ages for photonics and optics.

Steinbach: Still is.

Baney: It was at least five years, the hard times, and so during that time I had a very small group. We worked on optical vector network analysis, optical signal analysis, and also some interesting sensors like surface plasmon resonance sensors for biological studies, but it was a small team at the time because we had to scale back our activities. But during that time, we developed the groundwork for what later became an optical modulation analyzer. So a lot of the theories that were developed during the tough times came to fruition oh, about seven years later, six or seven years later, and so today in the optical networks you have very complex modulated optical signals flowing through them, and so a device called an optical modulation analyzer lets you understand the constellations that you're seeing and are being transmitted and the quality of the signals. So the work there did pan out, but it took a few years later that we did that. So that was an important one in the area of optics, and there were some other investigations that we did. At the time also, I had personally-- my job title had changed and I had moved up to Department Manager, so I was now contributing at a higher level in the organization.

Steinbach: Okay, and to a wider range of products.

Baney: Yeah, ranging from software, automation software, methods of automating software to nano-measurements, a variety of different technologies with a larger group, department.

Steinbach: And well, you mentioned also to me earlier that you're now getting into photonics ICs?

Baney: Yes.

Steinbach: Integrated photonics. I don't know how much you can talk about it, but...

Baney: Yeah, I've been following photonic ICs for a long time, like during the dark ages I was following coherent reception technology, optical coherent reception technology, which led to the optical modulation analyzer. Because the carriers were using complex modulation schemes so I was watching that in the committees and at the conferences. So that moved on, and then you could see now with the movement of photonics not only to long-haul and metro but it'll move into the data centers in a big way. And in the data centers, of course, the traffic is increasing-- pick a number-- 30, 40 percent per year, right? They're getting bigger and bigger, so at those kind of rates, the need to transmit information is just extraordinary. They have to plan 10x in improvements, and so I decided that it would be a good thing to launch a photonic IC activity because for the years prior I was working a lot with universities on photonic ICs, special projects. We published a fair amount, and so I thought, well, within the company it would be good to start looking at photonic ICs. So I launched that effort. Greg VanWiggeren is a Project Manager in my department. He's hiring in really sharp people, and we're looking at doing some really important things in photonic ICs. I can't say the specifics because that's proprietary, but the golden age of photonics is still just emerging. I guess we're just entering the golden age, which for me is photonic ICs.

Steinbach: That was going to be my next question. Do you see that all coming back after it totally crashed in the early 2000s?

Baney: Yes. I think around 2003 or 2004 when really the toughest time, you know, I said to one of the people in the group, I said, "The golden age of photonics is ahead of us. It's not behind us," because everyone was looking at how great it was during the boom, so now the future is ahead of us, and it really is. We're going to go with analog photonic ICs and that will be around probably for the next, my guess, two decades and then after that there may be a means of making digital photonic ICs instead of analog based and that will be the next revolution.

Steinbach: We'll see.

Baney: Yeah. <laughs> Yeah, check back in a couple decades.

Steinbach: But yes-- but I thank you for this assessment, yes. All right, so I guess that gets us to today, right? Can you give some more general insights about working in and managing high-tech R&D and the kind of people who do that?

Baney: Oh definitely, definitely. I think going into an R&D environment, actually any environment as a new engineer, always look at the quality of the people that you're joining. You don't want to be the big fish. Maybe in some cases it makes sense, but normally if you're looking to develop yourself you want to go in with the brilliant people and work with the best and in that environment you learn a lot and you become a manager and as a manager it's important to distinguish between applied research and development. And I'd say as a manager in applied research, the definition I have of applied research is that when you do a project it's likely that what comes out was unpredicted at the beginning. In other words, you didn't know in advance how the value came out of it, and so applied research has more of that flavor. You start it with an idea that you're going to get to point-- from point A to B. You have an idea, but often the technology you develop expresses itself in other venues, other ways, and so that's a sign of applied research, and so as a manager in applied research, you want to hire people in smarter than you. For me, that's easy. There's 7 billion people on the planet. Say we're looking for the upper one percent, right? That still leaves you 70 million people. How many are in the profession, and so forth? There's still lots of people. Hire the smart people. If you're doing development, you also want to hire smart people. They don't have to be smarter than you, but generally I think for the innovation you need really insightful people for applied research and so within Hewlett-Packard and Agilent/Keysight I think we've been blessed that I think we have really smart people. A supportive management structure is important. A great manager is Steve Newton, Waguih [Ishak], Darlene [Solomon], just wonderful people that's willing to support applied research and so that was important, as well. And another thing for me is as much as possible when you look at potential projects try to aim for the memorable. What is-- what are you going to do today that 10 years from now you'll remember? And so that's another gauge I use when I see project proposals. Is it going to be a memorable transformation? So...

Steinbach: Okay, so a question about the pull or the difference between applied research and development. I found in my field of IC design that we at the labs, because it's so expensive to make it, we had to do a lot of development. My suspicion is that you will have to-- that you will be pulled in there too as your photonics ICs become more complex and more involved to make. Do you see that, or do you think that's still a long way away?

Baney: That's a great question. So just thinking aloud on that, one big difference with photonic ICs today versus the kind of ASICs that you're referring to is we might pay $70,000 to do a run, right, on a wafer and the tool costs, right, the software tool costs we could probably do for $50,000 and so the upfront costs and the commitment are an order of magnitude less than the $0.5 million master or $0.75 million master. So from that aspect, the notion of back-planning isn't as critical for photonic ICs today as it is for electronics when you go down to 22-nanometer nodes and so forth. It gets very expensive. That said, it's not unthinkable in the future that photonics could evolve in a way that you have to do a lot more developmental aspects with less risk. I think that would be the direction, but we're not there yet.

Steinbach: Okay, and do you have a guess of-- is it going to be a decade until you get there?

Baney: I think so, at least a decade.

Steinbach: You think so. Okay.

Baney: Yeah, because photonics, in a way, it's all traveling wave structures, and it doesn't quite have the densities yet that you have in electronic ICs. Things tend to be large now. Photonic crystals, very small, very microscopic manipulations of light, as that evolves then densities could increase, and when electronics and photonics combine on a single chip then you're talking about you're running a 14-nanometer chip with photonics on it. Yes, exactly. You better do your planning. Yeah.

Steinbach: And the universities are looking into that, right?

Baney: Yes, yes, yes.

Steinbach: They want-- they do that kind of integration, and I've seen pictures of stacks with the electronics chip on top of the optics and all kinds of things.

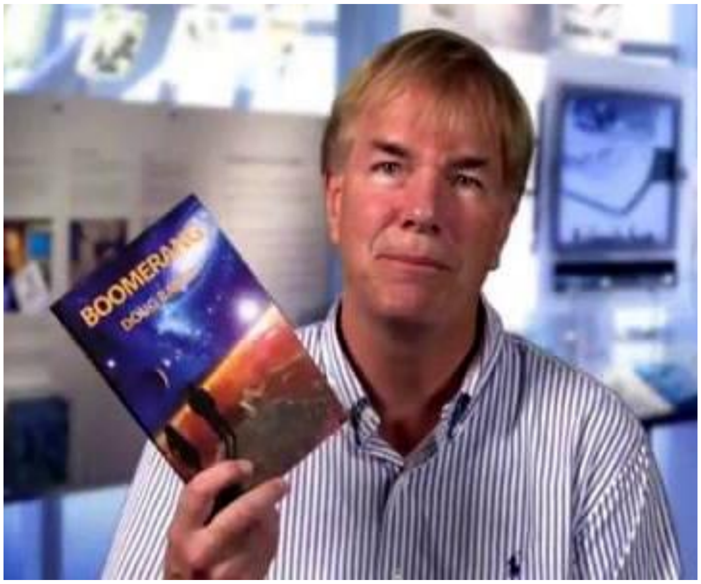
Baney: Yeah, yeah. So you can do the electronics at the front end of the process, layer the electronics on there, or the other way and like the folks at Berkeley who did this all in one, right? It was electronics and photonics in a single chip. Today, for performance it's going to be a more heterogeneous structure so the interposers and you can do the photonics separately, but one day, according to "Star Trek," right, we will one day have all this integrated and the back-planning approach, the investments, there's going to be quite a bit more.

Steinbach: Okay. All right, so how about outside of work, now? I guess we are through your career so far. Maybe you'll be back in 10 years. I don't know.

Baney: We don't know. It's not... <laughs> outside of work.

Steinbach: I found you as an author of science fiction books on Amazon, and I had to look: Is this the Doug Baney that I'm talking to?

Baney: I'm the same one. <laughs> Yeah, I got into writing a little bit. I have four kids. One is now at vet school, the youngest, in Edinburgh. My son is at University of Illinois. Two graduate, two girls from UCLA, and when they were young I used to tell them stories. The problem was when you read stories to kids when you're young, I'd fall asleep trying to read the story. I read it so many times, right, so the only way to stay awake for me was to make up stories so I was constantly making up stories. At the same time, I was-- I think around 1997 or so I contributed about 180 pages to this book, so I got my first experience in technical writing, learning how to combine mathematics and images and so forth, right, to make a book and so I had some experience with the book there and I published a fair amount also in the scientific literature. So I thought, well, I love hobbies and I wanted to do a hobby, so I started thinking about this story about a professor who's trying to figure out what a photon is. Believe it or not, nobody knows what a photon is, right? They describe it. They don't know what it is. So I started this series, and it's called "Boomerang Series," about a professor's investigation of photons and then the revelation it reveals and so forth and that came out as a science fiction book, and then I did another one which was the next one where bad things happen with artificial intelligence. <laughs> Right? Classic, classic. And then things happen on earth from a geopolitical standpoint after the bad things happen with artificial intelligence, so that was the interlude. So this series will probably be five books, and then I had fun with literature, just fun literature. So it's a story about a Chevy-Chase-like family that moves to Canada and has-- picks out the wrong Christmas tree and the bad things that happen, so it's a comedy. So I do get into writing, and I continue it as I have time.



Steinbach: So do your readers now know what a photon is?

Baney: I haven't figured it out yet, or plan to use artificial intelligence to solve that one and it's-- yeah. Einstein spent his career trying to-- at the end, trying to figure it out. Nobody has figured out what it is. I was-- the telling thing is that I was at Bell Labs having lunch with some great minds there, like Jim Gordon, famous for the Gordon-Haus effect, Lynn Mollenauer, their-- the Russian scientist they had there, and we're having lunch there and this is how the-- this kind of relates to the story, and we're talking about measuring solitons, a new kind of optical particle that we're thinking they need test measurement equipment for. So I finally asked Jim, "Well, you've been working with photons for how long, 20 years?" He nods his head, and everyone looks at me. I said, "Well, what is a photon?" and then he just stopped and no one spoke and he said, "Well, Bell Lab's management says we're not allowed to talk about that," because they spent-- I'm guessing they spent so much time trying to figure it out, they wasted a lot of time and nothing got done and so at the end of the lunch, finally Jim says, "Well, it's that which yields a photo-electron, like a solar cell, because we don't know what it is but it generates electricity," and so anyway, that sort of got me into the storyline in science fiction, how it started with the professor's investigation. I like music. I mentioned I used to play in a rock band, bass guitar, so I joined a band at work. What were we called? We were the Agilent Band at first, then we became The Splitz. When Keysight split from Agilent, we were called The Splitz, and I played with them for a while, had a lot of fun, but I just ran out of time and I'd like to compose myself but playing covers takes a lot of time for me, trying to understand how to play the different songs. So I left the band, and then when I have time I try to compose on my own. So that's how I spend some of my time. I also love astronomy and so recently went to Madras for the Great Eclipse. It was stunning.

Steinbach: Yeah. [last] Monday, right?

Baney: Yeah, yeah, yeah. It was Monday. <laughs>

Steinbach: I saw a little bit here, but I'm told it is very different if it's total.

Baney: Yeah. For me, being-- if you're in the 99 percent, 97, 90, down to 80, it's kind of like-- the metaphor I use is like a waterslide. You get on a waterslide. If you're not totality, it's like you have a three-foot drop. Oh, that was nice. Right? In the water you go three feet down. That was fun. But in totality, it's like you take that three-foot drop and all of a sudden- whoosh- exponentially it goes down and you just plunge into darkness and for me that was just astonishing, just how quickly that happened, and I looked up and saw the sky with the eye in the sky with kind of the flaming white-blue colors coming out of it.

Steinbach: Really? You do see that with naked eye?

Baney: With the naked eye.

Steinbach: Without a telescope.

Baney: I took off my glasses and looked at in totality. Now, you only do that for a few seconds because if it comes back on you can damage your eyes, but I did that and I could see Venus in the sky, the planets in the night sky. So it was stunning.

Steinbach: Okay, I-- anything else you want to say?

Baney: I think we covered the-- all of your topics.

Steinbach: All right, then.

Baney: I appreciate the opportunity to tell a little bit about my story.

Steinbach: I thank you very much for coming, and that's a very interesting interview.

Baney: Thank you, my pleasure.

END OF THE INTERVIEW

