
# Oral History of Nicholas (Nick) DeWolf

Interviewed by:
Craig Addison

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**Craig Addison:** Nick, could you talk about your entry into the semiconductor industry? How it came about? What company you worked for and so forth?

**Nicholas (Nick) DeWolf:** Fresh out of school I worked for GE and I wound up in the TV engineering department. And I got all excited about UHF television conquering America with the little stations that could have lots of extra channels. But to make it work we had to make it work at UHF which is a mere 800 megahertz, but that was a big deal in those days. So the only way we could build a workable TV set, surprisingly enough, was to abandon vacuum tubes at the very front end and put in a mixer diode whose technology was really very much the same as the radar sets used in World War II. So early television sets had a sort of, you might say, a radar receiver built in to pick up UHF. And then I got all involved in how to make those crystals which were vital to the whole process.

**Addison:** How long did you stay at GE?

**DeWolf:** I stayed there three or four happy years in a great big, comfortable, dreadfully boring company working on this weird little thing. These crystals, we really didn't really know how they worked. They were crystal and silicon with a needle stuck in the middle of them. And we just put them together and hoped they worked. And then that meant testing. Because I think at one low point no more than one third of them worked. Two-thirds of them went in the trash can. So the testing was vital to the UHF television game.

**Addison:** Did you get involved with anything else at GE? Any other types of devices or projects that are worth talking about?

**DeWolf:** Not really worth mentioning. I had the normal, two years actually, of bouncing from one thing to another. I tested machine guns. I managed to almost destroy a two million dollar power transformer. That was kind of exciting. I did my rounds as an engineer. In those days engineers were very important. And if you were a moderately good engineer and stuck to your last you would wind up top management. Very different from today where engineers have been often times treated rather badly I think.

**Addison:** Why did you leave GE and can you talk about how you moved to your next company?

**DeWolf:** Well, I went to conferences, a little like SEMI has been doing. Conferences were lively then. And on the way home from a conference about semiconductors a guy named David Bakalar had spotted me. I gave a paper, I guess, about diodes or something. And he impulsively offered me a pretty interesting job. He said that I could be the chief engineer of a new semiconductor company [called Transitron]. And I said, "semiconductor?" I hardly knew that's what I was building -- semiconductors. And lo and behold I stayed the chief engineer of Transitron through almost all of its career. And as chief engineer my job was to build production equipment and testing equipment for whatever we did, which led as many of you may know, into the whole general making of semiconductors.

And at Transitron we engineered and produced…discrete semiconductors. We made some integrated circuits but they were a trivial part of our business. And I had left the company before the integrated circuit revolution got really rolling. So I cut my teeth in discrete devices with wires hanging out of them.

  

**Addison:** Nick, could you talk about some of the highlights of your time at Transitron. Some of the projects you worked on and things that you thought were significant?

**DeWolf:** I am best known really for starting a company later that grew huge and succeeded [Teradyne]. But some of the most interesting semiconductor adventures I had were actually there at Transitron. And one I think…the story is interesting. Our first silicon crystal. Where did it come from? How did we come by it? It was very early in the game and we needed silicon to make very high voltage rectifiers. Very high, meaning a few hundred volts because we had been [using] germanium up 'til then. And there were no suppliers that we could afford of good quality single crystal silicon. So I think a lot of people have mixed understandings of how this all happened. We had to do things ourselves. There was really no semiconductor industry lying in wait with competitive bids on everything. Later on of course we took advantage of the whole industry. But I do remember this event that I thought was pretty exciting. Somewhere, somehow David Bakalar acquired a single crystal piece of silicon. And I remember being there with desperately bated breath. I don't think any of us ever held our breath as long again later as we did then. This piece of silicon was probably about a quarter inch or even less -- an eighth of an inch. It was just a little, tiny sliver of a single crystal of silicon. And there were only supposed to be…dozens of these in the entire planet available. Nature never made a single crystal of silicon of any size.

And we built a crystal pulling furnace. I helped to do that. It was radio frequency coiled to heat it up, and something or other to keep the silicon rotating. And we had fairly good silicon. Not really good by today's standards but we had a bunch of silicon we dumped in. And we melted it. And here we got this crucible of molten silicon rotating. And we had this lowering device. And now David Bakalar, president of the company, turns this crank and the silicon crystal -- the only one in the world as far as we could ever get a hold of -- is going to go down into the bowl of molten silicon and like a sperm and an egg, maybe it will take and maybe it will just melt away and go "poof". And if it melts away and it goes "poof", our whole hope, dreams of glory in the high voltage rectifier business would go down the tubes.

So we all were standing there. It was very exciting. Down came the crystal into the puddle. And it started shrinking. And David turned the crank back up and pulled out a magnificent, huge, single crystal silicon chunk from which the entire company sprang forth thereafter.

**Addison:** What was the key product that Transitron was producing?

ND: Well when we began, our key product was the germanium diode…still buckshot scatter, nothing controllable, sort of a hunk of semiconductor with a needle that touched it. We didn't understand the principals. It just happened to work. And then we wound up later on building the gold bonded diode which had a junction that was little more controllable. But essentially the challenge was; how to push a needle into a piece of metal, silicon. Make a connection. Overshoot to bend the needle a little bit by just about two thousandths of an inch and then take that and put it in the "to be tested" pile.

So we had to do hundreds of thousands of these. Zillions of them. And there were no machines. There was no SEMICON. There was no semiconductor industry. So now I will tell you a big secret about how we built the machine, which was no bigger than this box of Kleenex. I gave up on getting really fine quality threads to build a rotating motor that would squirrel in and out. So I used a micrometer from the local hardware store and it worked a charm. So here's the secret. We made millions of diodes using

  

micrometers screwing in and out, screwing in and out, constantly all day long. Row after of row of girls feeding the parts in. But a micrometer is going buzz, buzz. And that is how we built this empire of diode building.

And then huge Hughes Aircraft, which was a little known hero of the semiconductor business at the time we started, had perfected their glass diode. Diodes don't work when they get wet. Oh, do they hate humidity! And the only really sensible package is glass. But we didn't know how to do it. David Bakalar [went] against my advice…he was right, I was absolutely wrong. He went through heck to learn how to build machines that could build glass diodes, which is a tube with two beads at the end. And many of you know what a glass diode looks like. It's a little dingus made out of glass and two wires coming out of it. And we mass produced glass diodes in huge numbers. And they were used as rectifiers in small equipment and as logic devices in computers. And we became, I'm pretty sure, the kings of the glass diode. We made probably four times more than anybody else.

**Addison:** When we were talking before you recalled how Transitron recruited a lot of people from Europe. Could you elaborate on that?

**DeWolf:** Yes. Interestingly enough most of the West Coast people were…physicists and the people who designed the semiconductors were… what I call a little crassly, "eggheads" -- sort of intellectuals from the campuses. But we opted not in favor of that. We also couldn't find very many of them. And David Bakalar, the boss…he did the recruiting. He was an excellent recruiter. He went to Europe and recruited tons of physicists from all over Europe including England where we really cleaned out the semiconductor guys. So the guts of our technical staff were Europeans. And we often heard German in the hallways or French in the hallways. But they were mostly very ambitious guys. And in later years when the company broke up they started new enterprises in Boston galore. I think almost 40 companies spawned out of Transitron. Not many of them in semiconductors directly. But it was the European contingent, not the American universities.

**Addison:** At Transitron you invented a device that was similar to a controlled rectifier? Could you talk about that a little bit?

**DeWolf:** And this gets to a kind of discussion that we've been having about inventions versus discoveries. But this was definitely not a discovery. This was definitely an invention. I had the great fun of analyzing analytically and not mathematically, but thinking through all possible arrangements of many transistors to make devices that we could produce. And I was very excited about semiconductors and computers and I wanted to build a flip-flop that didn't involve so many parts. A flip-flop in those days was made from two transistors, a whole bunch of resistors, [it was] a big mess to build a bi-stable device that would be on or off.

And suddenly it was a eureka! Now here we have a problem. Who invented these things? Who discovered them first? The time lags here are measured only in months. Others may have been before me or after me but I think I was the first because I never heard of anybody else doing it. However we all were working in much the same areas and we invented and counter invented. I think the unique thing I did was what I later named the "binistor". I thought it was a pretty good name. We have the transistor and "binistor" would be binary transistor. So it was a four lead, not three lead, controlled rectifier in effect. Four

  

layer device. And it would make a wonderful flip-flop for computers. And to this very day I know that we could have gone in that direction if the planar processes hadn't moved in and the integrated circuit explosion [hadn't] taken place. This device required PNPN, which is a pain in the neck in a planar sense. So it wasn't as suited for what we now have today.

Essentially I feel, and this is perhaps not completely true, but I think I was the first, if not one of the absolute first to have this vision very clearly that semiconductors would revolutionize computers. And the computers with vacuum tubes in them were amusing but absolutely a dinosaur. It was going to be destroyed. So I got on a bandwagon to try to promote the use of semiconductors in computers. And I was roundly rejected by IBM and all of the big computer makers who thought that was utter madness. They thought of the transistor as this little lima bean with three wires coming out of it; that when it rained, wouldn't work. And it wouldn't take 200 volts like all their tubes would take handily. And they just didn't get it. They didn't see why this was the cat's pajamas switching device. And my "binistor" would have been in that family. So I had the fun of being one of the few who really, absolutely knew that the day was finished for vacuum tubes.

**Addison:** Were you ever able to convince the president of Transitron to move into this area? Did you try to talk to him about it?

**DeWolf:** We were very much a manufacturing company, not a research company. We didn't require big movements. What we required was orders and the ability to produce something. We'd produce things that were nothing like the huge plants of today. There were factories with huge numbers of girls doing this with a jewelers loop on. So everything was made more or less by hand. We had really pretty inefficient mass production which meant though that we could produce anything we could sell, if we could produce it. So it all came back to testing again because if the yield rates were around 5 percent, you'd better abandon hope. Nothing ever got over 90 percent acceptable rate. So essentially…let's take the "binistor". We produced all that we could sell. Not a problem. And the investment was trivial except for the marketing time to try to persuade the world to use them.

**Addison:** Now you just mentioned testing the devices. So your initial ideas about testing came during the Transitron time?

**DeWolf:** It was very obvious to any of us in that world that the testing was very much at the heart of the economics of the whole plant. Because the yield rates were often so low that if you were stumbling through a low yield rate when you put an object into a testing system, that decided whether it was worth $0.20 or $5.00. Wow. Therefore that test… needed to be reliable. We mustn't ship things that will not take voltage. For example, if you build a household power rectifier thing that just takes the power on a rectifier, which every TV set does, if the rectifier breaks down…the whole set goes up in smoke. And without adequate proper, clever testing, 5 percent of the TV sets would be imploding all over town. That's not acceptable. So the testing was much more important in semiconductors than other products which tend to be correct the first time.

**Addison:** So how did you actually test these devices?

  

**DeWolf:** We put voltages and currents on them and beat the dickens out of them electrically. Stuck them in furnaces and humidity chambers and sample tested and got bored with quality control lecturing and just plain got in there and tested everything.

**Addison:** While you were at Transitron did you develop any kind of testing machine?

**DeWolf:** Yes. I developed nearly all of the testing machines we used at Transitron. They were again pretty primitive because manual labor was acceptable in our eyes. We hadn't hit the necessity for automation yet. It was desirable but not mandatory. In fact, when I left Transitron to start my own company with test equipment, our first testers were manually operated. And they were very cleverly done so that eye, hand motions were all thought through. There were magnets to do the right things. There were a whole bunch of tiny details that were worked out to increase operator's production by about 40 percent. And if you could increase an operator's output by 40 percent, that's worth 20 percent of a year's pay. Good Lord. That's a lot of money. So when I started Teradyne one of the things I knew which none of my competitors would cotton on to for a decade was that what matters is productivity, reliability, solidness. Don't make big mistakes. Everyone else sort of thought measuring equipment was supposed to be very accurate run by people in white coats with goggles on, looking for 0.001 percent. So I used to boast that if at any time we competitively bid testing equipment that was any better than four times worse than our nearest competitor in accuracy, we had screwed up. We were always the most inaccurate testers ever made and we took pride in that. Because our testers kept working and making money for our customers.

**Addison:** So you're talking about Teradyne testers.

**DeWolf:** Yes. I'm talking about Teradyne testers. And I learned that lesson in helping to run a factory that made semiconductors. One of the things that gets missed a lot by people outside of the technology industry…it has a little to do with ethics, morals, drive, motives and so on. Most of us were offered jobs for twice our salary when we worked at Transitron. We knew we were onto something that was almost a "can't miss" proposition, namely the whole semiconductor field. We didn't really know that it would explode the way it has but we knew that we belonged; that it wasn't a myth or a "Johnny come lately"… just like the dotcommers know that the Internet is for real, even if their dreams of what to do with it were very, very unreal. But [there are] a couple of factors that I think had a big bearing on what we did then that I wish I could see more of today. One of which is that it was a lot of fun. We were on an adventure. It was very exciting, this adventure was. Here's a bunch of kids. Most of us weren't 30 yet. Our voices had hardly changed. And here we were knowing that the whole technological world would be impacted by what we had launched. Even in the most arcane corners of what we were doing it still was important. And indeed it has turned out to be much more important than we thought. You can hardly find anyone that doesn't have a computer of some sort. This house, if you count little, tiny timers and burglar alarms and things [as computers], there are probably 40 or 50 computers in this house. So it has changed our ways. It hasn't made us necessarily happier but those of us that were doing it had a ball doing it.

And we were not driven to get rich. We were not even really driven to get famous. Well, yes -- a little power lust. All of those human things are there. But we were…I suppose it's a little like a cowboy riding in a rodeo. Maybe he'll get famous but it's pretty gosh darn exciting when that horse takes you out into the

  

corral. That's how we looked at it. And I'm sad today to see too much "Enron-esking" where obviously those guys had nothing in common with our set of motives or ethics.

**Addison:** I understand that you used to be called a mad scientist during your school days, which seems pretty appropriate. What kind of things did you do during school and college and so forth that got you that nickname?

**DeWolf:** I still have the same nickname. I don't really remember what the movie reference to the mad scientist was but he was usually a long-haired character and was slightly nuts. I've had an interesting set of good fortunes. I had a good education which I hated in prep schools. So I learned how to write. And I learned how to do a lot of things that had nothing to do with technology. I had a very good math teacher and so I had a little head start on calculus and stuff before I went off to MIT. MIT was very fussy. And the school itself was dreadful, but the books were good. And my classmates were hard driving. So I had the advantage a really good, strong head start. And somehow that horrible athletic anti-geek prep school that I went to instilled in me a drive, a frantic drive, like a mad scientist, with his hair coming out his ears, to prove that all those football players were just guys with big muscles and no brains. So it made me very, very competitive to show them up. And in later years when they all went broke playing golf and I did OK as a geek with my white smock, I always had a little bit of a laugh because the standards of the old boys school were totally, 180 degrees, out of whack. They didn't do too well being a bankers…I was supposed to marry a debutante and be a banker. What a dreadful life that would have been. So here I am in my twilight years thinking back and thinking…I've really been lucky. I've had a wonderful life and done a little bit of everything. I've adventured and I've done what I darn well wanted to do without having to be greedy about it.

**Addison:** Nick, during the time of Transitron, what sort of competition was out there? Were you really hard pressed with a lot of other companies coming into the market? Or you had the whole thing to yourself?

**DeWolf:** No. Again as I explained, we could then reproduce a semiconductor device without huge capital expense. Thus competitors could do the same. And likewise we could do the same to competitors. So whenever a new device came along, bling, bling, bling, we were producing or they were producing it momentarily. None of these billion dollar foundry things were involved at all. Maybe the entrance of some of the suppliers helped, like you could buy pretty pure silicon. You didn't have to make it yourself. But it was so easy to duplicate somebody else's devices. And patents weren't effective. Or we could license them. We made a few integrated circuits, and I'm sure we licensed the T-squared L [TTL] family for example. You'd have to make TTL or you wouldn't have any macho in that business. But no. We had competition constantly. And the secret of course in such a situation was our ability to sell. And that had a lot to do with the aura of whether our devices were reliable. And they weren't always reliable. And some of our suppliers made horrible devices that didn't work when it got slightly humid. So the testing lay back at the heart of; "What could we do to make a more reliable product?" I know it's against all of the quality control rules but we had to test quality in since we couldn't always build the quality in.

**Addison:** You talked about selling devices. In the Teradyne history book written by Fred Van Veen, it says that you've been called an excellent salesman or a great salesman. But you also see yourself as an

  

inventor. Normally those two things are kind of mutually exclusive. How do you be a good salesman and a good inventor?

**DeWolf:** I think that's a very good question. How to be a good salesman and a good inventor. Every customer is a little different. Some customers couldn't stand an inventor. It would make them collapse because they don't want inventions. They want to have a good lunch in the right restaurant. Other customers really don't want a good lunch in the right restaurant. They really want an answer to their physical problems. So I think I probably was a very good salesman with certain kinds of customers. But with others, like IBM for example, I was a horrible salesman…because down in my heart of hearts I hated them; deeply resented them for their black shoes treatment of the computer.

I do think of an interesting little sales story. At the beginning of Teradyne -- it's an almost forgotten story but it was interesting. There was a guy from the most conservative company in the world -- Allen-Bradley. They made resistors that never went wrong. They were the quality resistor. But they also were a kind of an old fashioned, stodgy, solid company. And that's why you use their resistors in part. They had a reputation to protect that was very high. And all of their people were old timers who had been around in the field for years. Their products were not the latest but they were the best. And the guy in charge met me at a trade show. That's what trade shows were for back then. And I knew about his resistors. I really knew what was wrong with them. There was a fatal flaw…not fatal, but a flaw in carbon resistors, which I understood and none of my competitors remotely understood. They thought of a resistor as a perfect device. And I thought of it as a kind of a semiconductor. A couple of pieces of mud with a couple of wires stuck in it is bound to be non-linear. And I knew that. So he had a spec to see if us newer technology people would build a tester for him that would test this huge outpouring of Allen-Bradley resistors. I loved Allen-Bradley. And I'll be darned if I didn't land that order based on the design that I had; based on the way I went about it. And I built the only tester that would competently test his resistors. And I built a huge room full of these testers. They tested his resistors at the order of ten a second. And so one of the fun things when I retired is to sit back and say, "I designed and built the machines that, by God, tested hundred million devices. Way outnumbering semiconductors at the time". Just the pedestrian old resistor. Now that was a case where the engineer made a better salesman than the salesman because I was inventing the machine while I was sitting with [the customer].

**Addison:** Nick, could you tell us about your departure from Transitron? How did that come about, and the lead up to forming Teradyne.

**DeWolf:** Well, my departure from Transitron, [and] I don't have a negative memory of it, but the people who owned the company made the mistake of not sharing the stock with any of the employees. And as the second employee, chief engineer, I wound up paid less than I could from all the job offers I had. And so I realized that the owners of the company were not…it's not greed, but they just were not appreciating their people. We were all working for love. Then they went public. And they got on the front cover of Fortune Magazine. And it was a very famous article, called "The Gold Diode". It was all about the gold bonded diode which is what made us at that time. Usually a new venture was a part of an older, bigger company. We were absolutely a scratch, bang, new company. And growing like a weed in all of the demonstrable numbers. So the stock shot up. The people who owned the company [the two Bakalar brothers], were suddenly possessors of a big pile of dough…they had no idea what had happened. And they grew to believe that it was all just their own personal efforts that had made the company work. They

  

got a kind of overconfidence that it was their [two people's] skills that had made this whole giant empire even exist or succeed. Now that didn't upset me. But it meant that now we had two clubs. We had the inner sanctum of two men. And the outer sanctum of which I was part of with gosh knows, hundreds [of people], and then raw employees of thousands. I think we had four, five thousand people working for us. So I was independent in spirits, not financially, but in spirit enough to know that I could somehow manage on my own. And I believe I was the first key person to leave. The others left about a year later because the fundamental things that had caused me to get disillusioned they finally realized. I had realized it ahead of time. So I knew that my days were done there and I'd done my work and it was fine. And I had nothing unfinished that I had to stay to do.

And indeed the company got in all sorts of troubles and didn't last but a few years longer. So I knew I was going to go off an entrepreneur as opposed to going back to GE or some big company and being secure. I enjoyed the insecurity, the hard work, the long hours and the madness of the entrepreneurial world. As many of the Transitron alumni did the same thing in a totally different field than mine. None of them went into the field that I was in.

So then I decided it was time to figure out what to do. Here is a funny story. I also invented a form of vulture capitalism. Another guy was going to finance me and I was going to buy an aircraft hangar. And this is serious. And we were going to put 20 offices in the aircraft hangar. Now the biggest problem in entrepreneuring is the Xerox machine. It craps out all the time. To keep a Xerox machine working back then was just an agony of constant fiddlings and tunings. So we would have a central Xerox machine and I would take care of all the office gobbledy-gook and the rentals and everything. And I'd fill up this thing with 20 geniuses and their buddies. And they would sit there and cook up adventurous new companies. I was invested in them and we would own a chunk of them and it was sort of like the venture capital game. And of course only one in 10 would succeed. But that one in 10 would make us all very famous and rich.

Well, so I'd planned this thing and I had it all worked out and all of the balance sheets and stuff. And we were going to raise the money for it. And it met with some approval from various financial people in Boston who had run out of ideas. But I realized the fatal flaw. The fatal flaw was that I would have to personally fire nine out of 10 companies. "Out! Out of the aircraft hangar. Your day is done. You didn't make it." I don't want to do that. To fire a person is tough enough. To fire a company, that's really tough. So I realized that it's quite ridiculous to try to live off of one in 10 successful and nine out of 10 are bums. Not for me. So of course that idea disappeared very quickly. And I realized I really belonged in the semiconductor business building test equipment.

**Addison:** So when did this idea [for a test company] actually happen? Did it just pop into your head, or you'd been thinking about it for a while?

**DeWolf:** No. I must have a hundred different companies I could have started in different technological things. I'm basically an inventor/circuit designer. So I might have started an analog devices-type of company. I had a strange moral compulsion to not do what my previous company had done. I did not want to rip off, in effect, Transitron by just doing what they did only with a slant. So I had to do something completely different than anything they had done, as an obligation. And also as a challenge. And it was very clear early on that my connections, my friends…were with the diode industry where I had been to

  

many trade shows and known most of the people involved in making diodes. So I think it was in retrospect natural gravity that I would make diode testers for starters. And that led into the whole rest of it.

**Addison:** Now how did you go about getting the money and setting up an office and all the logistics?

**DeWolf:** Well we started the company in my house on Beacon Hill. I had several other potential business partners, none of whom made any sense. And I knew Alex [d'Arbeloff] back from school days. And in a way… he had not been successful. He will quickly admit that. He had been working in entrepreneurial businesses that were small and not very successful. I thought that was good. Everything I'd been involved with had exploded and blossomed into hugeness overnight. I wanted somebody who'd had the tough experiences of not having such good luck as the fields that I'd been. And also very important. I wanted somebody with the same ethics that I had. Although Alex' family was quite different than my family, our ethics were very close…have always been very close together. We've almost never had ethical disagreements.

Briefly I'd known him at ROTC, which was a Reserve Officer Training Corps. Very superficially. Not really closely. But I could sense intuitively that he was good for me as a partner. And I knew that, just like a marriage, a good marriage can be wonderful and a good partnership can be wonderful. So I think I really lucked out. Now he was not understanding of what I was talking about for quite a long time. I did really a very high percentage of the engineering at Teradyne subsequently. And so I really understood the gory details of exactly why we did everything that we did. And Alex was to sell and manage and I was to create. And in some cases, like the Allen-Bradley thing…that was my baby all the way through. But once again when we got nice orders from Allen-Bradley, it was Alex' job to be sure that we produced them.

**Addison:** Nick, how did you raise the money to launch Teradyne?

**DeWolf:** Well of course we were terrified of that, raising the money. For many…for me [it was an] unpleasant, difficult task. But Alex and I spent a whole year designing a business plan. We really didn't know what we were talking about. But we really worked out a theoretical business. We never lived up to that business plan, but it included all these details. And frankly our first financing was F&F, which is friends and family, almost inevitable for your early financing. But I got asked once; "what are you doing about inventory control?" As a geek what the heck do I know about inventory control? But Alex and I had been through this. And on paper I said, "Well here. That's on page 26. See, inventory. We're going to turn inventory over three times a year." That number I knew was acceptable to those [the venture capital] guys. I didn't know if we could turn the inventory over three times. But I knew that was what we should shoot for. So we had this paper company. We did not push impulsively out there and go raise half a million bucks in two minutes flat. We raised money from friends and family; enough to keep us going. And then came chapter two, which was very important, which was American Research and Development. One of the first venture capital companies headed by a wonderful Frenchman named [General] George Dorio. And they invested in us [Teradyne] and became our second financing and carried us clean through going public years later.

**Addison:** What was the first product that you produced at Teradyne?

  

**DeWolf:** We made a diode tester that was beautifully engineered. But the first product that brought money in was the resistor tester. Now one of the philosophies I had, which was very key… I had always run out of parts. We'd get an order for the something or other. Drat! We don't have such and so. So the whole thing is sitting on the shipping dock lacking this one part while we all go bananas on the telephone trying to make something happen that doesn't want to happen. So I had a mania about what I called "the standard parts system". And [at] our company, Teradyne, we used -- maybe this is an exaggeration -- but I would guess we used 50 times fewer parts than our competitors. Our competitors were always saying, "Where is the 1N, the 2N something or other." We would say, "Ha. Ha. Ha. We've got a warehouse full of everything we use because we don't have but just this fixed set of parts in a very flexible business." So designing how we did our drawings; how we did everything…I designed Teradyne to be a custom house which I called semi-custom. We really were putting together modules and bits and pieces that we'd done many times before. Typically I would talk to a customer about what he needed and be designing it on the airplane home and have it in the factory in the next morning.

**Addison:** How successful was the diode tester compared with the machine to test resistors?

**DeWolf:** It's kind of interesting. There were only about 50 human beings who could possible order a diode tester. Sort of like a medium cocktail party. That's it. That's the only people who even knew what the heck we were talking about. And I knew, let's say, 48 of those 50 people. So we built the diode tester. We were very proud of it. It was really well engineered. And we had the big coming out party, which took place in several cities. East Coast. West Coast. Midwest. We used sales reps, of course. That was the thing you did in those days when you were starting up. Well, I explained to my 50 close buddies what a great machine this was. And there was this stunned silence. Absolutely, huh? From all of them. What have you done? And here was the real lowest insult of all. At least five of these people came up to me after the presentation and said, "Nick. We love you. But we have no need for what you've done. What you've done is the silliest thing we ever saw." I mean it was…expensive. Not heartbreaking but it was expensive. "I feel sorry for you, my friend. And after you quit, give up. Then we'll come back and we'll see if we can't help you find something else to do." So that was the worst thing, for your friends to feel sorry for you. Never mind they didn't just say, "No."

Well, time went by. That's when we did the resistor thing. Time went by. The capital began to dwindle. Alex' fingernails disappeared. No orders came in. We were really in trouble. And at some magic moment all these people suddenly understood what I had done. I don't think it was because we did anything spectacular. They just suddenly got it. This was not a machine for a laboratory for geeky people to go investigate. This was a machine to sit on a big factory and go kachunk, cranking out diodes. Nothing to do with laboratories. They all had been wooed by General Electric…Hewlett Packard, Tektronix and General Radio. They all built very classy, kind of mahogany boxed stuff. Not me. My stuff was built for the factory. Suddenly they got it. And when they got it we were absolutely drowned. We couldn't produce enough of them. And up we went, off the charts. And then boom! The ups and downs of the semiconductor industry may be bad but some of the equipment suppliers really catch it. Sadly enough I never understood this. Semiconductor manufacturers and our competitors and us; in bad times we'd tend to quit engineering. What a dumb thing to do. That's the big golden moment to start thinking about tomorrow. But people lose their confidence. So our ups and downs were quite fierce. And we neared Chapter 11 dozens of times. And somehow we lucked out. A couple of times, very close.

  

I had another role at Teradyne. It was tough. I won't say I enjoyed it but I did take that responsibility. I did the firing; even though I wasn't responsible for administration much. But it took guts to fire 15 percent of your work force one afternoon. And I did that because I thought that was one of the most important tasks as CEO that I would do is I would not shirk my duty when it came to one-on-one talking to people and saying, "Sorry, Suzy or Sam. We are in deep trouble and you've got to go." And, of course, I told everybody that they'd be better off without us. And I think one in five bought that. But I never got threatened with a firearm. But a couple of times it was close.

**Addison:** Can you talk a little bit about the competition? I know Fairchild over on the West Coast was getting into testers. But what sort of competition did you have during those first few years?

**DeWolf:** What sort of competition did we have? We really had no competition on our grounds; on our grounds for our earlier machines. There was just nothing like them. The only question was whether you wanted one; whether you could cough up the money to buy one. But we had no serious competition on our own grounds of transistor, diode, manual testing. Then later, when we built computer testers we were the first. So again we had no competition for that very important jump. Later on we got competition. And here…it kind of had something to do with my leaving Teradyne. Not the competitors directly but the customers' demands on what they wanted rose and rose and rose to bigger and bigger and bigger machines; more and more and more expensive machines. And a one million dollar machine was considered ho-hum. I could no longer really understand those bigger machines. And we had to lower our standards. My standards were so high for quality, reliability, appearance, ruggedness. For example…some of the slogans that I coined, which we stuck to until I resigned; a single adjustment involves the responsibility for having to screw around with it the rest of your life. We had no adjustments. We guaranteed our equipment for years and years. Don't touch it! Just leave it alone. It will always do what we said it would do. You did not tweak our equipment into working, which all of the other equipment was…including the first computer testers, [which] were not tweaked into working. We guaranteed them for years and years and years. And we met that guarantee and the maintenance did not crush us because the machines were, let's say…you could put your arms around them. You could understand them. You could break them into pieces and see which pieces were strong and which were weak. And then improve the weak ones. The competitors, however, and Fairchild was certainly one of them, responded as the "B" school would have you respond, through customer demand. They paid very little attention to what was right or wrong. They paid attention to what they were supposed to build. As a result they had to have a way lower standard than I had. Their machines were filled with twiddly, doodly…it must be Monday so the voltage is low so we'll jack it up on Tuesdays. Oh, goodness. To my standards [that was] garbage, absolutely garbage. But it's what the customers were willing to pay for it because they wanted bigness. More is better. Bigger, bigger, bigger. And you cannot test a 775 pin computer [chip] with a cutesy-pie little box. You can't even hook it up with a cute little box. If I were absolutely God, I could have just said to the customers, "No. No. No. Come on, now. Let's invent our way out of this monstrosity", which is how I wanted to do it. But the existence of competition who were willing to do what the customers asked for…and that's what the "B" school says. Total quality…it just says, "Do exactly what the customers want. Don't do your own thinking." So it was all quite repellent to me. And one of the reasons I retired is that I really didn't want to lose control of beautiful machines to sort of having to build great, big sloppy ones. And there was no option, according to the sales department. And in a way that probably turned out to be true because subsequently Teradyne did build big, monstrous machines, breaking all my rules of which the biggest one was – "no fans." I never shipped a piece of equipment with a fan in it because a fan is an

  

invitation to disaster. It's going to stick. It's going to break. And then the whole machine breaks. What's it there for if it isn't needed? A fan is a disaster.

Well, I went away from the company for a year and I came back. Sure as heck, here's the latest Teradyne invention and it has 72 fans in it. Oh, my gosh. It's like it had AIDS as far as I was concerned. So all my standards started going down the tubes. Another one was "no adjustments." I actually caught somebody two years later putting a potentiometer in the middle of the circuit board and I really embarrassed him. I wasn't powerful enough to fire him but I would have fired him right on the spot because that was a religion; an absolute religion. No adjustments. And try building test equipment with no adjustments. Give it a whirl. You'll find it's very hard to do. It's at least 30 times harder.

**Addison:** While we're talking about competition, did you ever have any concerns about the Japanese companies or were they present during your period?

**DeWolf:** Well I was present when they were starting to take pictures of trade shows. Click, click, click. And I was amused by that. Because they asked all the wrong questions. Although I do remember a Russian spy [story], even more important. I stopped a shipment of our testers to Russia. You may remember that a MIG [fighter jet] was taken over to Japan by a Russian defector, and then therefore finally able to be really taken apart. And it had no integrated circuits in it. And I felt partly very proud of that because the Russians were trying to buy our equipment in order to make integrated circuits. Naughty boys. Well not naughty boys, sensible boys [but] we didn't want them to. So I felt I had a little bit of a kernel in the slowing down of the Russians. Today of course it's a crazy story.

But the Japanese hadn't yet become a major competitor as I was retiring. They were apparent. They were appearing. They had some thrust. They had some successes. As we discussed earlier, I don't think they copied us. They couldn't have copied us. But they did apparently copy Fairchild, and bless them. They were copying the wrong machine.

Yes, we had big ups and we had big downs. And at one big down Alex and I were really looking the end in sight. We'd have to pull the cork and that would be the end of that. We were the only company like us in downtown Boston. And Boston would miss us and we were already starting to cry about the funeral. And ARD, our venture capitalists; the staff of ARD were voting against us. They said they'd looked over the papers and the books and according to the "B" school we'd had it. We would require new sales at an unheard of rate that would rescue us from disaster. And they knew that we would "B.S." our way into optimism no matter what. So they didn't trust us. They trusted them and we were just about to go under. I don't know whether it was he or me but General Dorio was the boss and we used to call him the Velvet Glove because [he was] a very aristocratic French guy. Wonderful, charming demeanor, very beloved by everybody in Boston. And a main teacher at the Harvard Business School. The General said, "Nick. We will have lunch." I said, "Yes. We will have lunch." I think he bought the lunch as a matter of fact. Very key is who buys the lunch. That's some sort of part of the ritual. And do you drink? In those days we drank a lot at lunch. It was a terrible mistake but the tradition back then was martinis. And jeepers, the sales department would be sozzled after lunch. Well neither the General or I had a drop to drink [at this lunch]. We knew this was serious. So all of a sudden half way through the General looks at me and says, "Nick, do you think you will survive?" I said, "General, we are going to survive. I know it. I feel it in here [my heart]. We've got it. We're at the lowest point right now and we will make it." There were no papers, we

  

had no file folders, no spreadsheets of any kind…so General Dorio said, “Nick. I believe in you. March forward.” Or something like that. And he produced another quarter million [dollars] or something. And [he] absolutely saved our neck. And indeed we made it.

That is the old fashioned way of doing business. And to this day I can’t really read a spreadsheet. It’s more like a score card that it really is like a decision-making thing. Most decisions I’ve found are really not too borderline. They’re really pretty damned obvious. Do we fire this guy or not? We’ve been trying to fire him for 10 years. We finally have an excuse. Should we set up an office in Paris? Alex said, “Yes.” I said, “No.” I said, “No” because I thought it was a waste of money and time. But Alex is partly French and of course he wants a sales office in Paris just because that’s a prestige item with him to conquer the old country. So I said, “OK, Alex. You can have your [Paris office].” But the decisions were not subject to analysis and spreadsheets. And those that were, were boring and obvious anyway.

So let’s take the decision we talked about before -- to use very few parts. That could not come from the “B” school. They wouldn’t know anything about how many parts you use to do a certain task at work because they’re not interested in details. I’m really very excited about the details. By having a hugely less complicated inventory, our whole factory was super productive. Their [the competitors] factories were mired down in parts problems. So that was not a detail. It actually spelled whether or not we could ship on time and therefore get the order. I’m very proud of the fact that today Teradyne lives by many of the same religions and does the same business that I set up. It follows the same thread, with a very different management philosophy, I’m sure. And much more formal and much less intuitive. But you’ll have to ask Alex if he will confess to bad business mistakes that were our fault. But we did survive. And many companies did not.

Now we used to boast -- this bothered me a lot, but Alex enjoyed it -- how many competitors we buried. That’s speaking not of us but of others. It’s embarrassing. We buried competitors on a regular basis because they didn’t get it that this is industrial machinery. They thought they were building high geek technology instead of much lower geek, but still very difficult, rugged industrial stuff. And I’m famous for having stressed the expression “speed kills” because our machinery…didn’t necessarily go fast. What they did is they went well. So we built [machines] that were more like -- we used to talk about it -- more like a Mack truck and less like a hot sports car that goes over the cliff. Weren’t we called the Mack truck of the semiconductor industry? I think that’s what we were called.

**Addison:** Just going back a little bit. You talked about the diode tester. But after that I believe you developed the transistor tester?

**DeWolf:** Yes, which was very similar, based on the same principals.

**Addison:** Was that a huge success?

**DeWolf:** Yes, for all the same reasons. Now the success again didn’t depend on our clobbering competition. Alex may look at it that way but I don’t as much. The success depended on whether the customers really needed it at our price. Could they afford what we did? Because it was priced quite handsomely. And it had to be because of the care with which we built it. And then the transistor tester got so complicated. It had so many dials and knobs…it got to be a pain in the neck to just set it up. And that’s

  

when I began thinking; why don't I use a paper tape reader that will go "click" and set it up? That would make sense. And then all those knobs and dials would be set up and then you'd change the paper tape. Pretty primitive. [Then] it became obvious. Bingo. Light came on. To hell with the paper tape. We'll use a whole computer. Because the machine has gotten to where they could afford a whole computer. Now I had to do the designing. I had to design circuits that could be computer controlled that were quite foolproof. But I'd already been thinking half way in that direction so it was not agony to do that. The agony was to get the computer to behave itself.

**Addison:** So this is obviously the J259 -- the automatic IC tester?

**DeWolf:** J250 something. There touches a cute one. A part of the lore is that all [Teradyne] machines were [given] prime numbers. And I insisted on that as a good luck charm. Well the moment I left the company, boom! Three new models were not given prime numbers. Why not humor me? They just didn't know any better. That was when the "B" school moved in. They had no charm.

**Addison:** So this automatic IC tester was kind of revolutionary.

**DeWolf:** Very.

**Addison:** And that was run from a computer. Can you talk about how you came up with it?

**DeWolf:** Just like when I knew that transistor would revolutionize computers. There are some revolutions you just know are going to happen. It would be a little like taking a steam engine out of a car and putting in a gasoline engine. You just would do it.

**Addison:** What was the reaction of the customers?

**DeWolf:** Horror. Shock. Oh, my gosh. And with an IQ of over 20…yes, of course. Naturally. Now, can we afford it? It was an easy sell if they could afford it and if we could demonstrate the software. The software only had at the beginning to emulate what our knobs and dials were doing, which is pretty easy. A pocket calculator will do that today.

**Addison:** How was the industry changing? The IC had started to be produced in volumes. Did that make your job a lot different, the products and the design?

**DeWolf:** Yes it did…because the ICs were so much more complicated and they were much more digital than analog. In other words you had a lot of pins to screw around with. But you really couldn't reach in and measure this. With the separate devices you could reach in here and measure this because there were wires on it. But with an integrated circuit you don't have wires.

I remember an episode that might illustrate this. I had built a personal reputation as really understanding the trade. Not the business about who, what? But what's needed. That was my specialty. I used to have a crystal ball that had bubbles in it. It was very hard to find a bad crystal ball but I found one. I was very pleased with it. Korean, I think it was. It was on my desk and I said, "The reason I'm the boss here is that

  

I'm the guy that has the crystal ball." I could see ahead. Most of the other people, because they were following customer demand, were not seeing ahead at all.

Now another thing that had a big effect on us…Graham Miller. We had a defection. He started a competitor to us that was right head-to-head and did take some business away from us. I think he was more of a threat than the Japanese at the time I left.

**Addison:** Which company did he start?

**DeWolf:** I forgot [the name]. Graham Miller…he had built a company of some size.

**Addison:** Not LTX?

**DeWolf:** Yes.

**Addison:** Teradyne also bought Megatest. Was that after you left or during your time?

**DeWolf:** It was in the process. And we bought some of the very much smaller companies. So when I talked about competitors going under, some of them we bought out. But we weren't on a big acquisition kick. Now you see, to do those bigger machines was not easy for a very small company because they didn't depend on one or two strokes of genius. They depended on a lot of brute labor to get all that stuff together. Power. I just learned that Teradyne is trying to build a power supply. I so disapprove. If I went back there again I know I'd be charging around saying, "Ridiculous. Come on. Let's put quality back in instead of just muscle based on customer specs. Let's think it through ourselves." But I'm sure I would be very unwelcome. There would be people shooting at me in every hallway.

**Addison:** Now I've seen photos of you, Nick, with very long hair down past the shoulder. Did you say you grew it just to be a rebel?

**DeWolf:** No. It wasn't to be a rebel and say, "screw you." It was to say, "I'm my own man. And when you tell me I should this or that, ha, ha, ha, you're not going to get very far." So if you tell me I should lie to the stock market, for instance, be careful because I'm not the sort of guy that's going easy to push into that. So I guess it was a statement; not so much a rebellion against the system. I think you can sense, my life has been my own much more than most people's. I don't know. My kids thought it [the long hair] was cute. The company put up with it. The "B" school could care less. They'd push me aside. I can't read a spreadsheet and I have long hair so who the hell is he? Well I'm the guy that is in charge here. Tough shit. If I tell the stock market we're screwed, the stock market now knows we're screwed. I didn't like the "B" school very much. The people were OK but I didn't like their approach. And when they invented total quality control, I almost was sick every day to hear that prattle. The theory being that the customers know what they want -- that's reasonable -- more than you do, so get your engineers to go build what they want. And that attitude was totally intolerable to me. Now they didn't try to persuade me. So I let my hair grow and it's falling out now from chemotherapy. But it was long until a year ago.

**Addison:** So Nick, did you have any involvement in the overseas selling or marketing of the equipment?

  

**DeWolf:** I think the answer to that is pretty much no. But I think an interesting thing is…in the early days, I thought of Silicon Valley as overseas. Because it was so different than the easterners who were busy with way more primitive semiconductors. But they seemed more productive and less egg headed. And I underestimated the beginnings of the integrated circuit which of course went crazy, wonderful, the planar process and all the things that had followed. But Alex took the overseas business very seriously because he had the responsibility of setting up sales organizations there. And it's very strange. It's probably still strange in Europe but it was even stranger then. Everything was through sales reps of one kind or another. And every country had its own flavor. And none of these people knew anything about integrated circuits or semiconductors. But plants were getting set up or overseas branches of American plants were getting set up and they needed equipment. But they didn't understand really hardly anything about it. So that was much more selling at lunch. And having the right wine in France; chilled. The right amount. And sent back five times. We couldn't believe it. Our French rep sent the wine back five times to have it within two degrees C of the right temperature. That all seemed to me so ridiculous to waste grown-ups time on that. And actually I was wrong. That's exactly what mattered in France -- was two degrees C in the wine.

Now in Italy Alex and I had one of the few times we had a really strong ethical question. It was a rare, rarity. In Italy, as I knew from childhood reading, the idea of bribery is a way of life. It's like it is in a communist country today. You've just got to bribe your way through. Well that ran really counter to Alex' ethics. And I was not much in favor of European offices. But when Alex learned that in Italy you've got to bribe your way to sell a tester. Alex said, "Well screw it. We won't sell testers in Italy." And I said, "Sissy. We will too. We'll bribe the guys according to how you're supposed to bribe them. After all that's the national custom." He said, "I will not yield to national customs because we have a high moral standard." And since he was in charge we did not sell anything in Italy. But I think there were times later towards the end of my time when the European business saved our necks. Because the American ups and downs…some of our real low points in Silicon Valley coincided with a high point in Europe and saved our necks. So in point of fact it was a great…what do you call it? …buffer zone. Therefore Alex turned out right. It was a good thing to have done it.

**Addison:** Your resignation or departure from the company actually was around the time SEMI was formed, I believe. 1970. Was it '70, '71 when you left?

**DeWolf:** Yes. '70. '71. There was a big moment when that happened. I spent about a year in the realization that I was the wrong guy to run the company. It was serendipitous that the right guy to run the company was Alex [d'Arbeloff]. But that wasn't why I was the wrong guy to run the company. It wasn't Alex versus me. I had started losing interest in the bigger systems. I was not keeping track of the customer ebb and flow. I was not so close to the machines themselves. I began being more distracted. I got burned out. I'd designed with these hands 350 different testers. So what the hell is the 351$^{st}$ tester all about? So the part that I really liked best of all, which was to design the testers, had begun to sort of slip away. And I'd begun to lose interest in it. And I actually realized that I would be, in the long run, bad for the company.

If I had the role of guru, [or] B.S. operator presenting to the stock market, that would be OK for the company because I wasn't too bad at that. However I made a mistake. This mistake weighed heavily on me. Still does. And it relates to the morals, ethics, Enron thing again. We had reached a point where we were really in trouble. And as I resigned we were indeed in trouble. I didn't resign because we were in

  

trouble. It's just that we were in trouble. And we were to present to the stock market the annual, whoopee event…and I remember telling them the truth. I said, "Fellas, we're in big trouble and we're going to go down for a while because the semiconductor market is down." I told the stock market the truth. These guys…that did the stock analysis were quick making notes. Next day in the Wall Street Journal or something; "Teradyne announces troubles ahead." Suddenly…I had alerted them to the fact that we were in trouble. That was a mistake. That's not the rules of the stock market. You are supposed to just forever tell lies to the stock market. That's what you're supposed to do. If you were a really good CEO, like Mr. Enron, Kenneth Lay, I watched the TV of what he said to the stock market and I read the book. Absolute bald-faced white lies. Not white lies. Bald-faced lies. That's what the stock market expects.

**Addison:** Well of course that's changed now. You have to be super truthful.

**DeWolf:** Yes but back then, we had a higher ethical standard than we've had in recent years since dotcoms and Enrons. So that wore very heavily on me. I realized that henceforth I'd be a front man; a guy that presented images. I'm not too bad at that. I could do that. I may even cut my hair off. I don't know. But I had long hair just to say, "Screw you." I did wear a necktie, yes but I mean I would not pander to what the "B" school was expecting because it revolted me. They didn't know anything. They just knew how to manipulate spreadsheets.

So if you add all that up you can see a guy who realizes he doesn't belong in such a big company. I didn't really belong as the public decision-making guy for the company. And I don't normally admit this. So I thought about it for a year. And I mumbled about how it should be reorganized and I realized I couldn't do that. I couldn't reorganize the company if I quit. That's not cricket. If you quit, you quit. Then the next guy reorganizes. It was obviously to be Alex. But I considered other options and it was very obviously Alex. And so all of a sudden on a Friday to the total surprise of Alex and everyone, I stood up and said to Alex, "Alex. It's yours. Now you're the president. Run the company." He nearly fainted. He had absolutely no idea this was coming. There were no pre-negotiations with anyone, even though I had done a lot of thinking about. It was just that I would kind of look around and try to think it through without tipping my hand because I wanted it to be a surprise. Alex was the happiest man on earth. It was like unbelievable because that's what he wanted to do. And it made good sense. So boom! I quit. And I had trivial, unimportant things like chairman of the board and other things to do there. But truthfully I wanted to be finished. So that's when I invented the other shoe drop idea. The company was having an internal war between the "B" school and the engineers. It's quite a standard war in all companies. And I knew that my buddies in the engineering crowd would be heartbroken. If I bailed out, they were losing their protective clothing. Too bad. I wasn't about to save them. And I happened to live walking distance away [from the office]. I could have come back every week and mumbled something trying to save them. And I knew that wouldn't work and that wasn't cricket. So I went to Asia for almost a year. I don't know exactly but it seemed like a long, long time. And I absolutely loved Asia. And in that fashion I could die. Nobody knew where the hell I was or what I was up to. They were able to forget me. I really like Asia a lot and I enjoy adventuring all by myself. I was just me. Period. No mission. No credentials. Just a passport. By the time I got back the wars had decided themselves and everybody knew that Nick was gone. And about a year later I came to Aspen [Colorado]. And in Aspen I never told anybody what I had done. This kind of thing didn't happen. They had no idea. They thought I was some strange, long-haired inventor. Period. So I had the fun of living in Aspen as a mystery fellow. All the others…everybody knew every drop of their

  

business history and most of them were in real estate or Hollywood. So nobody knew anything about Teradyne. What the heck is that? It suited me fine. It was great to start a new life.

**Addison:** So you've been here in Aspen 30 years now?

**DeWolf:** 32 years. Yes. Recently, because I appear to be croaking of chemotherapy, the town has been very sweet to me. They're giving me all sorts of…you'll see the walls covered with these plaques for contributions to the town. So I made a list of what I've done since I retired. I've been involved in almost 100 different projects here in Aspen. Amazing. And most of them are community oriented. And almost none of them involve writing big checks. So I've had a wonderful life since Teradyne. But the whole experience that we've been recanting here has been a wonderful life for me and I wish more Americans would become engineers; fewer lawyers and doctors. And I really wish for one thing with great passion and that is that physics should be taught before biology and chemistry. The simple, simple high school physics is the heart of everything I've ever done. Without it you're stuck. With it you have a chance to say, "Wait a minute. How tiny is that mask and what's the wavelength of light?" Those kinds of things. So if I had any one thing I'd love to see happen, it is that America would get more technical again.

**Addison:** Thank you very much, Nick.

END OF INTERVIEW

  