

Better before bigger: How Linear Tech was built

An Interview with Linear Technology's Bob Swanson and Bob Dobkin by Steve Taranovich, editor, EDN



Bob Swanson, Chairman of the Board (left) and Bob Dobkin, CTO (right) have been in the electronics industry since the early days of Germanium transistor technology.

I recently visited with 2015 UBM Ace Award winners for Lifetime Achievement: Bob Swanson and Bob Dobkin. These men are an important part of the early days of electronics in Silicon Valley and have seen the transition from Germanium transistor designs in electronic circuits, on through to the early days of the Integrated Circuit (IC) and finally, culminating in the co-founding of Linear Technology, deemed one of the most profitable and successful companies in Silicon Valley today.

During my interview I was very intrigued as to how these two different personalities with two different skill sets would seamlessly complement one another's answers to my questions in an alternating manner that painted a picture of who they are and how they have grown up in Silicon Valley acquiring skills and insights into how to start a company and bring it to such a prominent position in the electronics industry.

The talents and experiences of these two leaders, in my estimation, has brought about a corporate culture unlike most of the companies in the electronics business today. This culture encourages innovation and strongly values and recognizes the company's engineering talent so that when a good idea emerges, management recognizes it and "gets out of the way" to allow the engineer to bring it to fruition.

Read on and prepare to witness unique insights into early Silicon Valley, a tutorial in how to start a company and create a successful corporate culture that lasts for decades and a lesson regarding management-level cooperation and success.

EDN: I am so impressed with Linear Technology's longevity, but in particular the fact that the same two men who started this company 34 years ago still guide the company and have created such an employee-friendly environment from day one in which to thrive and especially value their engineering talent. That philosophy is still in effect at your company and you guys are still influencing this company both in business and technical advances.

During my 42 years as an engineer, I had some experiences at some of the companies at which I was employed where engineers were really undervalued and under-appreciated. At one company, the engineering department was told by a manager there that, "You are all overhead."

Bob Swanson: About three or four years ago we invited all the sales people to come in to headquarters for a sales meeting. The area sales managers come in every six months, but it was some time since all the sales folks were out here. So I was asked to give a talk to the guys and tell them about the beginning of the company. And they wanted it to be motivational. So I was thinking about 'What is it about Linear 30 years later that enabled us to avoid mistakes that other companies that I worked for made?'

So I told the story about three other companies that I worked for that weren't just other companies; I worked for them when they were at the zenith of their success---but it didn't last. One was Transatron; and what happened to Transatron? During the first recession their sales went from \$60M to \$38M, but the one thing they weren't worried about was engineers. Engineers were a commodity; they could get in a plane and go to London; they could go to Holland; they can go to France and get all the engineers they wanted and by the way, pay them half the wages that US engineers make. So that was my first appreciation for my thinking that when you run a high tech company, you had better appreciate your engineers: especially the exceptionally good ones---they are not overhead, but a special, special asset.

Then I went to Fairchild Semiconductor during the "glory days" with Bob Noyce and all those guys when Andy Grove's business card said that he was a Device Engineer. So this was really the 'glory days; they innovated everything---this was magic and I was a young guy there. And then that thing fell apart in a little over ten years. I was too junior to really know what was going on but the rumors were that Sherman Fairchild, who was a great entrepreneur in his own right, but didn't understand the chip business, didn't understand the investment, just didn't understand how fast-moving it was and how you had to fund it. The whole thing imploded.

So I went with the guys that went to National at the same time that Andy Grove and company started Intel. What was the lesson there? The lesson was that top management had better understand that this is a fast moving business and there are investments to be made, and if you don't make them---you're history. But you can't overspend either, so there's a balance.

So then I went to National and that's when I first met Bob Dobkin. It was just like being in the Marine Corps, as people said it would be—it was so 'gung ho' there, everything was great and when it came to analog we were clearly the leader. Then, about two years before we left, they went to matrix management and all of a sudden there was all kinds of bureaucracy and politics and people like Bob and I got demotivated. It was way more than the fact that they didn't know where analog was going as a future.

So when we started Linear, we said that we were not going to make those same mistakes.

Bob Dobkin: And analog is unlike digital systems. When you make an analog product it takes six months to get it out to the customers, another six months for them to design it in, and another year for their product to get out. So you really don't see any business for two years or maybe three years on a new product. You have to understand that in this business and be able to handle that. You have to think a couple of years ahead and have them ready when they are needed. Management has to understand that these products are not going to sell in three months.

Bob Swanson: Especially hard when the design cycles become 18 months or more.

EDN: Both of you have been in the electronics industry since the early days of Germanium transistor technology and have grown and excelled personally over the last 50+ years as successful engineers as well as founding Linear Technology and bringing that company to a very profitable and influential position in the analog semiconductor community in so many ways. To what do you attribute this successful longevity? I can't think of many, if any, electronics companies that have achieved such a long and successful run with the same leadership and engineering-oriented corporate culture in this tough industry of ours.

Bob Swanson: When I was at National and ran their Analog group, there were three design groups--the Advanced Linear group that Bob Dobkin ran, Standard Linear ICs that Jim Solomon ran and a third one that was Consumer Linear Integrated Circuits (CLIC) headed by Tim Isbell. A bunch of us were getting frustrated near 1981 and I decided I was going to leave. I was thinking "How do we get this thing started? How can we possibly succeed? Especially in an Analog business where a lot of people think it's last year's technology." So I said 'What can we do better than everybody else?' And 'Is there anything we can do better' because if we can't answer that question yet, we might as well stay at National.

The choices I had involved Bob (Dobkin), who was running the Advanced Analog Group, but he was making really 'slick' general-purpose things like voltage regulators and amplifiers and so forth. The other groups were working on things like speech recognition and speech synthesis and a lot of way, far out in time projects. So, if we were going to get this company to get off the ground, we couldn't have projects that took five years to get any sales. His (Dobkin's) products

went to market quickly and saw sales after a year and a half. OK so that's three years and not 5, 6, 7 or 8 years. So I said let's start this company. Bob (Dobkin) is the guy that I want to start it with!



Bob Dobkin points to his 43 patents on Linear Technology's Patent Honor Roll.

Bob Dobkin: It's important that when you're coming up with products for a new company, you have to give the customer a benefit. Right from the start we tried to give the customer a benefit in performance, we provided support, and when complications came up, we were there to help the customer. And it's Bob's (Swanson's) fault that we have efficient manufacturing, good delivery and we never gave the customer anything to complain about regarding the products.

EDN: As a circuit design engineer I used Linear's products in the 80s and I was mostly amazed at the really great technical applications force you had; they were always around when I ran into trouble and needed help. We used to call them the "Ninja" applications engineers because they would appear out of nowhere.

Bob Swanson: There are so many answers as to how we did this (i.e., started the company) and one of the answers is a recognition that everyone believed that Analog was kind of dead and had no growth and Digital was the 'wave of the future.' That showed up in a lot of ways like in colleges when kids were deciding which discipline to take and it also showed up at

customers. Everybody was Analog-challenged, the world in general was Analog-challenged, customers were Analog-challenged. We said---look, we have this disproportionate share of Analog know-how; the world has this great demand so we have to be able to supply that. It was an advantage that we had. We're going to make ICs, we're going to sell them to customers who are Analog-challenged. The more we can hand-hold them and show them how easy it is with our help, the more we can get a premium for what we do. We would tell customers that they were not paying for the silicon but the engineering expertise we just gave to you. And that worked.

Bob Dobkin: We were careful when we hired our field applications engineers. They were all experienced design engineers. They weren't salesmen. They didn't have permission to give prices.

Bob Swanson: If you were an Analog Aficionado, Linear Technology looked like a bunch of great technical guys just doing analog and they wanted to be a part of that. After 34 years we are still the same. We can hire as many good people as we can afford to hire. So again, the great thing we have going for us is that we have a disproportionate share of really innovative people. We leverage that because the world needs innovative analog solutions.

Bob Dobkin: We have a culture here which is not empire-building. We are very careful that people do not have their own empires. Everybody who works for Linear is working for Linear. And it is important for everybody to realize that. Then the cooperation is great, the interchange of ideas is great; we are all marching to the same tune. It helps the company and the customer.

Bob Swanson: If you don't have that, the company gets destroyed and it comes back to creating a culture where as you get bigger you do get some bureaucracy. As things get computerized, you have systems like approved product lists that determine which products you can build in the company's factories---but we can live with that if we keep it to a minimum and make it easy for the engineers. But we have to keep politics to 'zero.' If we can do that then we can have the right culture indefinitely. But when those two things get out of hand, people get frustrated; innovators get frustrated.

Bob Dobkin: One of the things we do is to hire engineers who want to innovate and build products. And then we don't get in their way. So they build products, they like what they are doing, and that works well within Linear.

Bob Swanson: So regarding your previous question as to how we got started--- there are so many potential answers, but as I said, I thought about this in the last three or four years with people asking similar questions on our 30th anniversary. And back in 1981 when we said 'Hey, we're out of here!' I was in my early forties, had kids in high school getting ready to go to college. I was looking to start a company that had some longevity; I was looking for a job for the next 20 years. So when we said 'Can we do something better than anybody else?', the answer was 'Yes!'---there are several things we can do better than anybody else. The strategy really was to **'be better before we were bigger.'** Just be as big as you can as long as you are better than anybody else. And the other thing was, 'How many customers really want something

better?' We weren't quite sure. But we said let's do things that will enhance our longevity. We wanted to be around for 20 years ---well we made it to 30+.

Bob Dobkin: If you do some products right, they will sell for over 30 years. If we do some products as good as they can be done—you never have to do them again.

Bob Swanson We had to be careful not to wander into areas that were going to require a lot of resources and we couldn't be sure whether we could do this better than anybody else. Are the results going to be so compelling that it will be worth this big investment? So we were careful in the early days how we spent our resources. We couldn't afford early on a lot of mistakes, a lot of 'dud' product ideas. Our batting average had to be really good in the early days. So that played a role in not doing super-risky projects requiring lots of people.

Bob Dobkin: Also, we couldn't get into price wars. We weren't that big. And getting into a price war, being able to sell things cheap---nobody at Linear ever thought that was one of the advantages that we would have.

Bob Swanson: Well you know there are companies that choose to be innovators and then there are those who choose to whittle away at cost. As a strategy, if you can be really efficient, that might be a barrier to entry—but it's always temporary. Because somebody else always comes along and figures out how to be equally efficient. Like the story I was reading about Compaq Computer. But if you continue to innovate---that's a barrier to entry that can last for decades.

EDN: Other companies envy your profitability. Numerous financial journals have commented on that as well. The corporate environment that you have created seems like an obvious way to have a successful business yet I can't think of another company that does what Linear does especially for 30+ years.

Bob Swanson: You may or may not know that I am the technical fly-weight in the company. When we started the company we said that we were going to make products and be first to market with them, and that they would be better than existing solutions. Don't tell me what the product costs---tell me what the product is worth. So we quickly realized that pricing products based on their functional value, while doing a sanity check on what it costs is a good approach. So many people start with the cost and mark it up two or three times and think that that is a good business model. We always ask, 'What is it worth to the customer?' If we sell a customer something for \$4 that replaces something for which he is now paying \$5, why isn't everybody happy? Why would you care if it costs me \$0.50 or \$1? I just gave you a better product. I think that might have been a new kind of culture.

Bob Dobkin: And at the same time, there is a lot of infrastructure for the product. If they needed help, it was there right away, including the design engineer, if needed to fly out to customers to help them.

EDN: When I was a circuit design engineer in the 70s and 80s, I would get calls from the receptionist when a vendor in the lobby wanted to see me. If it was the guy or gal who just would drop off literature and disappear when I needed help, then I would ask that they leave the

literature for me. But if they were the guy or gal who would stay close and support me after I bought the product and put me in touch with the factory people who would solve my problem, then I would see them even if they did not have an appointment. Designers are busy people trying to get products out the door within a very tight schedule framework.

Bob Swanson: Well that has been so important to us, but obviously we have great products. But competitors have great products too. In this Analog-challenged world, we have been so good at transferring our knowledge leverage to customers. I will occasionally see the big customers at social events. They always tell me how much they depend upon our design and field people. Our field people are brilliant FAEs. I tell the customers that those technical experts are what you are paying for. Look at our P&L statement--SG&A and R&D. Manufacturing costs are less than that. So don't open up our part to see how big the silicon is or how big the package is or how many leads are on it. Look at the things that you love about it---that's what you're paying for. They might go away grumbling but thinking about that.

Bob Dobkin: In terms of efficiency, we can't design a product without good test engineers and good product engineers. It's the whole package that gets the product out into the customer's hands and keeps it running smoothly. Right from the beginning we realized that we needed good techs, good product engineers; the whole thing. Also, our products have longevity. It's nice to have engineers that also have longevity in case we need to answer questions about something that happened ten years ago.

EDN: The other thing you bring to the industry is your knowledge base; the three volume set of "Analog Circuit Design," the excellent data sheets and application notes. I remember reading EDN early in my career and smack in the middle of the magazine was a Linear Technology Design Notes application article.

Bob Swanson: We knew that we had this resource and it was valuable so let's properly exploit it. Regarding data sheets, I can remember like it was yesterday, sitting in Building #1, reaching an agreement that first impressions are really important. So a bunch of us, Bob (Dobkin) and marketing people were talking about data sheets. They needed to be data sheets with characteristic curves based on real data and applications that were actually breadboarded, and we agreed to color-code the parameters that were are really going to test over temperature. I thought that was a good idea, but I didn't appreciate how big that was going to turn out to be. Even today, if you ask about that, people trust and respect that our data sheets and our app notes. But it came back to that time sitting over there in Building #1 and discussing how they were going to be the best data sheets that engineers were going to pick up.

Bob Dobkin: I set up what goes into the data sheets back when we started and even to this day I proof all the data sheets that come out of Linear.

Bob Swanson: And you catch mistakes.

Bob Dobkin: I catch mistakes. There's no reason for me to proof anything if I don't catch mistakes and do something for it. But I read through it and sometimes see inconsistent specs and these have to get corrected.

Bob Swanson: You know that the people who are doing the data sheets know that Bob is going to be looking at them and they don't want Bob to catch them making a mistake. The data sheets are a part of our credibility.

When you start a company you sort of set goals to be the best in this, to be the best in that; if you can be the best in a lot of them, those are the ingredients for success.

I think that the single battle cry I have is **'better before bigger'** as I mentioned before. If you do that you won't get out of control. We're a big company now and struggling in some respects to figure where we go next in all these different areas that we are involved in. Again, "better before bigger." It's so easy to take low margin business. Low margin business becomes big business and you staff up for that big business and if that big business goes away---that's how companies get into trouble (Bob Swanson is indicating a sine wave with his hand). We have never had an ego; I've never had the ego to say 'Unless we're a \$3B company by the year 2000, who is going to pay attention to us?' Let's just be in business, let's make good profit, let's not have to have layoffs every cycle and that will be OK with me.

Bob Dobkin: We manufacture our own wafers; to be a good Analog supplier we need to have control of a lot of specialized processes that don't come from foundries. We've got processes that we developed especially designed for Analog. Forty years ago everybody did Analog on the same bipolar process; it's not the same now.

Bob Swanson: One of the challenges going forward is you can't afford to spend \$2B to set up a new fab to support \$100M of business. There are some things that good business sense says that 'You can't build a fab to do that.' But here's a \$100M piece of business we can make money at, but we'll have to depend on somebody else's fab. But it is true today that 95% of what we do---part of the 'secret sauce' is in the wafer fab.

EDN: How do you feel about Moore's Law. Is it important to you?

Bob Swanson: Moore's Law has never been an issue for us. I think that's true. Bob (Dobkin) may have something to say about that.

Bob Dobkin: When you're designing Analog, your device sizes are set by your Analog parameters---your voltages and your currents, not by how much digital logic you can put on a chip. Moore's Law, for increasing density and reducing cost does not help Analog---the reduced feature sizes do help if we want to go really fast. The small line width digital processes we use need it. But for the most part Moore's Law makes the mask costs go up.

Bob Swanson: So it turns out that we have lots of projects now that have a great deal of digital content for the first time in the history of the company. When we got into the business, we designed functions that lasted for 20 years. Now we are involved in some markets where we design a function and it's a winner, but we see a cost curve (Moore's Law has never been an issue for us because our circuits don't scale), so we are in a situation now where there is significant digital content. To stay in the game we actually have to transport this to a new node, mostly because the digital is getting smaller and the other stuff will benefit too. That's kind of new to me.

EDN: Processes are going to 28nm, 14 nm and the voltages drop down so much that how can you get any dynamic range out of your analog?

Bob Swanson: We've been going from 0.65um to 0.35um or 0.35um to 0.18um and all of a sudden we have some product where that's an issue. If it were just Analog circuitry, for the most part, it wouldn't be an issue but we have so many 'ASAP' types of products that have lots of digital content that you have to be sensitive to what the right node is for that type of product.

Bob Dobkin: And with some Analog products, if you were to go and try to do something in a 14nm or 20nm node, the costs of the masks are in excess of \$1M. The volume on these products may not pay for a mask set at that cost.

Bob Swanson: There's no Analog function that does that.

Bob Dobkin: So our nodes now are 0.35um and 0.18um for the most part. A nice combination of Analog techniques resulted in a [temperature measuring circuit](#) that interfaces with many different sensors. It linearizes and offsets the parameters of the sensor to read out directly in temperature. It takes a digital engine to do that. But you have to have the Analog expertise to do the front end of the solution.

EDN: I give credit to you guys for embracing digital technology where it enhances the product for the customer.

Bob Dobkin: We need to supply benefit to the customer.

Bob Swanson: And a more complete solution.

I am a little surprised to see how much digital has wound up in our products. Our designers convinced us that if we want to keep the strategy that has been working for us and give customers a complete solution, make it easier for them then we have to put this digital on the chip.

Bob Dobkin: And the customers now have more digital in their systems so we need to talk to them.

Bob Swanson: One of the things that you may not be aware of is that we're involved in many big projects, but the majority of our sales still come from products that sell \$1M, \$2M, \$3M or \$4M a year and it's taken several years to get to those sales numbers. But those are so defensible, and so for us when we think about a project in a lot of our areas, we don't say that that will be a \$100M product--we say that will be a \$3M to \$5M product and that will be a winner for us. But you can't afford to have ten designers to work on it for ten years either. So selling 'widgets' is still a big part of our business.

If you're going to do BMS (Battery Monitoring System) chips and PoE (Power over Ethernet) chips and really complex data converter chips, you have to understand that what's putting gas in the tank are all these 'widgets' that we make that are the best in the business.



Linear Technology even has managed to have some of their components aboard a 2014 SpaceX launch.

EDN: One of the things you guys have not done much of, and I have seen it so prevalent in our industry, is have many acquisitions. It makes me dizzy in just what's happened in the last year in the way of mergers and acquisitions in the electronics realm. However, you did make a pretty significant one in the Dust Networks acquisition which stands out.

Bob Swanson: That was big for us. It was one of those deals where if it didn't work, it wasn't going to kill the company either so we didn't 'bet the farm' on it. Over the years we said that we're a specialist. Most acquisitions involve some company that is for sale for a reason and some other company thinks that if they buy it somehow it will help both of them. So there have been a lot of Analog companies that have been available for sale and we look at them and say 'What can they do that we can't?' And we chose not to do the stuff that they are doing, so why would we want to buy them?

Dust Networks was a unique situation that when I first saw it I thought it was a solution looking for a problem. But there were a lot of people in the company that thought that the Internet of Things was going to be real. I met with the Dust Networks people and the one thing that struck me was these guys seemed really, really smart and really understood what they were doing. But if you're not a specialist then how do you know that what they are telling you is really good and smart to do and on target? But we have a good group of people here that were convinced that

these guys were capable of providing the best product. And many people here hoped that this market was going to develop and when it did that we were going to be really well positioned.

Bob Dobkin: They had one of our basic tenets. They provided a benefit to the customer. When you implement something that is wired you typically need a lot of wire and labor to wire it. Or instead you implement a wireless solution. There is a big economic benefit for going wireless if it's as good in performance as a wired solution.

Bob Swanson: If somebody said that 'Hey, the Internet of Things is going to be the wave of the future,' well I've seen many waves of the future that didn't turn out to be waves. And if they said it is going to cost \$1B to buy them, I'd have thrown myself in front of it. But many people here felt strongly that this was a good thing to do. If it worked, we're brilliant; if it doesn't work we're not putting the whole company at risk.

From my point of view, the people in the company are so excited about it, especially in the field area, I worry about how much time they're spending on it (laughs). Everyone tells me that on a product-to-product basis it's like a Linear play and we have the best product.

I remember talking about Energy Harvesting ICs five or six years ago and that was all the buzz. There were no sales at all yet, but people believed that in five to six years there would be. You do have to sometimes play in these long-term relatively high risks, but you have to have enough balance so that you've got stuff that's putting gas in the tank every day.

Bob Dobkin: Some of our long-term developments, like a 20 bit A to D SAR converter, are unique in the industry right now. That didn't happen overnight. It took years of development before we came out with a product.

Bob Swanson: But if that were the only product we had, we would be out of business, so we had lots of other products in that area that were selling and allowing us to spend money developing these long-term projects.

Bob Dobkin: In the engineering group there is very little talk about what companies we should buy. We have enough things of our own to go build that we know from experience that they will be good sellers and be profitable in the marketplace.

Bob Swanson: If one of our Analog competitors gets to an area first, and that looks like a good area, we'll get there as a fast follower.

EDN: There are so many times that some of the purchasing people want to save the company money by going to a lower cost part from a competitor. And sometimes that can work, but I have seen so many times that the effort actually costs more than the ultimate savings because no one in engineering has explained what the cost benefits of the present part are and how much it will cost to replace the existing solution.

Bob Swanson: There is a recent situation where a company was using a complex product of ours and they were getting a lot of pressure from purchasing to design us out because competitor A had a part that sold for 20% to 30% less. This was a high ASP product with

significant dollars, and it took a very high level guy in engineering to blunt this by explaining that if they used the other part, it would not work as well as Linear's and would involve hiring three or four engineers, so they decided to keep using the Linear part.

Bob Dobkin: When you have products in the marketplace for 20 years, and have been selling them to the same customer for 20 years, giving a 5% reduction each year is unrealistic, but some people keep on asking for it.

Bob Swanson: So what happens then when they don't appreciate the present solution for a product that started at \$0.90 twenty years ago and is now down to \$0.50 and that's it---there's no more to give. Sometimes we have to say that there's no more blood left in that product, we can't sell it for less or we would be sending you money with each part, so we're going to obsolete it. Then they say, 'No, you can't do that!'

Bob Dobkin: That's what happens in the digital area. They'll sell a product for 5 or 6 years and then obsolete it and do the same thing in a smaller node.

EDN: Then it's lower power, smaller package.

Bob Dobkin: And higher price.

Bob Swanson: And the supplier can actually continue to be profitable. If you try to explain to a purchasing person that I have a BiFET op amp that doesn't scale, sometimes they just don't want to hear it. Sometimes they just don't understand the technology. Some people have asked, "Why can't you put that 1 ppm reference on a fine line width process?" Well, one wafer would support the world for the next five years.

EDN: Analog is a whole different animal.

Bob Swanson: But it's a good animal and we love it!

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Linear Technology
Predict Featured on Cover
EDN, May 10, 2001

Linear Technology's high speed ADCs were touted on the cover of this May 10, 2001 edition of EDN. [Jim Williams](#) wrote articles for EDN from May 5, 1975 to 2011.

EDN: Well, you guys have been around a lot of years and that says a lot about your company and the respect it has in the industry.

Bob Swanson: When you think about it, we have to be proud of what we've accomplished. And a lot of it was, 'Wow, this is what we said we would do.' We set these high goals. Some say 'Nobody sets goals nowadays,' but then a little while later they say, 'We've almost done it!'

Probably the greatest thing is the culture we have with these really bright engineers who choose to work here. They could work anywhere, and they have rough days and good days and there are times when we won't do exactly what they want, but they get most of what they want. And they feel that it's an inspiring environment and they stay with us, and they innovate, and they do things that other people can't do.

EDN: Some people say that digital technology is absorbing much of what analog has done over the last 50 years in semiconductors. What are your thoughts for the future of Analog?

Bob Swanson: I'm surprised to see that question because in the early days it was asked during the first ten years of Linear. Whenever I'd go to a conference, I'd get 20 minutes, and the first ten minutes was spent explaining to everyone that Analog is not dead! After the 'Dotcom bubble' people started appreciating and saying 'Wow, analog is a pretty important part of this Dotcom thing.' So hardly anybody asked me anymore. First we would remind them that the Analog market went from \$2B to \$44B and will get to \$50B. It will always be a small piece of the total vis-à-vis digital, but almost everyone on Wall Street has no notion that Analog is going to be sucked up by digital solutions. They now know almost every product you can think of at some point needs power and that's a big market, so it looks like Linear is part of the world forever.

EDN: Light, sound, heat, vibration can be digitized, but they need to be put into a language that processors understand. To actually sense analog signals, you need to amplify, filter, and convert to the digital realm for the processor to begin its work.

Bob Dobkin: If it has a real-world parameter, it goes into Analog.

Bob Swanson: One of the things that you (Bob Dobkin) told me was that power was Analog. So take an automobile with hundreds of processors---every one of them needs a power supply! And it is typically a power supply that is way more difficult than it was 20 years ago. The challenge in this 'explosion of electronics' in the automobile seems to me to be as much about solving Analog issues as digital issues.

Bob Dobkin: That's a very harsh environment though in the automobile.

EDN: That's a tough market to get into. The automobile manufacturers want to know that you're in it for the long-haul.

Bob Swanson: So I'm sure you have heard the story that 7 or 8 years ago we were deeply involved in handsets and we didn't see a happy ending for us there, so we got out of this, to the chagrin of some people. And so we said that automotive was going to be one of the markets that was going to make up for that. And we said that this thing about cell phone handsets is going to be where the customer wants more and more integration and less and less price every year. And he wants these cycles to be every 6 to 12 months. It takes us 18 months to design these products with a team of people, so were not going to do them anymore.

And automotive was the place. Automotive used to be pretty commoditized and price sensitive, but now we see that this wave of electronics and the solutions are challenging. And it looks like they need a lot of innovation. I met with some senior people 7 or 8 years ago in Europe and Japan, and I heard twice from very senior people, 'OK Linear, you want to be in this business? You need innovation and you need quality. If you can't do both of those, you're wasting your time.' Well, we're good at innovation and quality, so maybe this is a good fit for us.

EDN: Well handsets turned out to be a 'bloodbath' in pricing.

Bob Swanson: Everybody eventually knows that this is not a happy ending. I think these big handset companies are going to wind up with one or two players that have no other choice but to sell 60% to 70% of their sales to a single customer. And they will be beholden to those customers.

Bob Dobkin: Even TI got out of it.

Bob Swanson: I knew (Tom) Engibous—did you work at TI when he was there?

EDN: Yes, he was the CEO for most of the time that I was there.

Bob Swanson: You may or may not know that we did a strategic alliance just before we went public. That was when he ran the Analog group. In a way, TI has had a lot of courage---they got out of the military business, they got out of the digital business and they have shown the ability to do some gutsy things.

The Burr-Brown and the ADI people saw us and said 'Hey this Linear Technology might turn out to be something' and they all wanted to do deals with us.

EDN: It's so refreshing for me to witness your unique corporate culture when I meet with your marketing engineers and design engineers, a real bright group, and I can see that they are all very happy here at Linear. You listen to all their ideas and give them opportunities to run with an idea. It's almost but not quite like a 'Mom and Pop' organization but certainly a close relationship between management and designers.

Bob Swanson: We need to keep that. National got to be a \$1B company and they said 'we have to have matrix management...' they totally messed things up. Even then I thought that just because we are a \$1B company, I don't understand why we have to change anything. Some of those things they wanted to change were the reasons we got to \$1B. Why would you change that? Well they did anyway.

So, I think we can go a long way with this structure. I hope that when I'm gone that they don't change very much of it.

EDN: Look how far you've come.

Bob Dobkin: At our size we've kept the same structure that we had when we were smaller. And we're growing with it. And I think the management here has seen that this structure works. There's no reason to change it.

Bob Swanson: The only thing we changed a few years ago was when we got to a point where we said 'Everybody can't report to Bob (Dobkin).' We broke the company into product groups: Power, Signal Conditioning and so forth. Then Power got so big that we split it in two because if you've got two really smart guys---it's got to be better than one smart guy. So we get to the point where we dice things up to an area where they can really focus--because we have to beat the competition.

Bob Dobkin: And we have to keep the customers happy.

EDN: With that attitude, you can't lose.

Bob Swanson: With good people, you let them do the right thing and stay out of their way and help them when they need you to be there.

Bob Dobkin: Our attitude in the beginning was to help the customer. Even if he doesn't buy your product, he will come back to you next time. Do him wrong and he will never come back to you next time.

Bob Swanson: I remember in the early days, our FAEs would design in a TI \$0.50 part. I would say we have a \$1 part---what are you doing? The FAE would say that 'He doesn't need our \$1 part Bob (Swanson). We have three of these really good Linear parts designed in and he needed a linear regulator, and the \$0.50 part is just good enough and if I try to force a part on him that he doesn't need, it will come back to bite us.'

Well, I reluctantly gave in to that.

EDN: It's great that that type of culture filters down to all your employees from you guys.

Bob Swanson: That's a culture I had to learn. I used to say 'Hey, we're in business here and we could be out of business and our success isn't official---what do you mean you designed in a TI part?' They convinced me that it was the right long-term thing, and we're not going out of business next month!

EDN: It's all about transparency to the customer and being honest with them and of course, you have to make money as well. But that's building relationships.

Bob Swanson: I've learned over the years that designing in the parts that are the right parts that the customer needs and not stuff that they don't need---in the end goes to our credibility.

EDN: I had interviewed a bunch of people about the early days of early IC technology when I wrote my first feature article for EDN, [Analog: Back to the Future](#), and the new engineers nowadays have great tools like simulation, etc. but what I see in my travels is that engineers are losing that feel and insight for the transistor and what it is doing inside that IC. So many designers just plop down an RF amplifier or data converter without a full understanding of the functionality and what's happening inside that IC. Simulations are excellent in today's electronics world, but I find that many designers do not know the true limitations of that tool. What do you think about that with regards to IC design and also circuit design? First let's look at IC designers as a case.

Bob Dobkin: For a lot of Analog functions, the simulation is only so good. You still have to understand what you're doing when you make an IC. Simulation is much better than it used to be, but there are still some things that don't simulate like the interaction of thermal effects in power devices. You have to know what you're doing there. When you're doing really high speed circuits, you need to understand what's going on because, not only are you simulating transistor circuits, but you're simulating the package and everything outside to make it actually work properly.

From the customer's point of view, many of them know more about IC simulation than transistor circuit simulation. Some do, of course, but not to the depths that you need to design an IC. Plus, if you're designing an IC, you're using lots of MOS devices as well as Bipolar. The small signal MOS devices are not readily available as discrete devices. We, as designers, have to know the transistors because that's our business. We have to know how to simulate them and when the simulation doesn't work, we have our own SPICE internally that's used, as well as commercial simulators. And we also give our LTspice out free to our customers so they can simulate our models when they're doing a system design.

We probably have the world's most popular SPICE with over half a million downloads.

Bob Swanson: That's an interesting point that Steve brought up. What I learned in the early days is that the Analog guys really had to understand the silicon, more so than the digital guys did. When we talk about the digital guys, sit them down at the computer and they can immediately design things. And I understand, over the years, how we've had to advance our tools because the products got so complex that engineers said, 'I can't do this anymore without these tools.' And I knew the tools were imperfect, but the question you asked was, 'As we deal more and more with better simulation and better tools, are the engineers losing that feel for the silicon that they had to have 15 years ago?'

Bob Dobkin: No (emphatically stated)—they're not losing it. Circuits are more complicated and they still have to understand the silicon and how it interacts with the transistor next to it. The only thing that we've done is that we made it easier to get it right the first time. And there are still things that the simulator doesn't handle. So, we do the simulation and we do it to the best of our ability and then we do the rest of the debugging on the chip because if the simulators were perfect, everything would work the first time. And that happens a very low percentage of the time.

EDN: OK, now let's look at circuit designers. My first boss said to me, 'Don't even think about breadboarding that circuit idea until you make sure it works on paper'---this was in the early 70s. I had to go through Kirchoff's equations in a circuit diagram and do the analysis by hand first. Are we creating a whole new generation of designers?

Bob Dobkin: Yes we are. We're seeing many people who do not know how to design the circuit that way. They find it faster to throw it in the simulator and keep playing with it on the simulator until it works---we don't want those guys here at Linear in IC design. They have to know how it works fundamentally and then use the simulator as a check.

Bob Swanson: I think we had some circuit designers here that didn't even bother to breadboard because they are so complex.

Bob Dobkin: None of the ICs are breadboarded here, they are all done in the simulator and then go to silicon. The simulator is the breadboard. They don't just put it into the simulator and try to make it work in the simulator without knowing what it's supposed to do ahead of time.

EDN: When I was a circuit designer in the 70s and 80s, I had the power specialist, the processor specialist, the software person and I was the Analog guy. We were all specialists and designed in the area of our expertise. Nowadays companies run leaner and the person that needs to do Analog design is most likely the same one who is implementing the microcontroller and doing the software and, by the way, he now has to supply power to the micro and maybe add an external data converter or some other analog function.

Bob Dobkin: I think what's happening is they've got a system that they're working on and they have to get their system working. If they can take a piece of pre-designed Analog and put it in there, they know it's going to work, and then they can work on the rest of the system. That's his beginning. And if we can give him a hand, then he can go on with the rest of the design.

Bob Swanson: It seems that with some of these really complicated digital chips like FPGAs and so forth, the designer finds out that after they design this great machine, they discover that powering it is a huge challenge. And that knowledge is usually beyond them.

EDN: Right, you're dealing nowadays with tiny voltages and huge current demands.

Bob Dobkin: FPGA companies put out reference designs, many of them have Linear power devices on them, and if the customer deviates from the reference design---FPGA companies typically will not support their devices. They don't want to get phone calls because the customer tried a different power design and now it's not working.

EDN: Even if the designer changes just one component in the case where they want to use a different supplier's part, that can cause problems. I had a design in the 70s when I was asked to get a second source to a National 555 timer in an existing circuit design. I was to find a pin-for-pin second source and went to RCA at that time for their '555' timer. Well, the data sheet for the RCA part was identical to the National part. It worked in the circuit during all my preliminary tests, but later in production, the RCA part failed to work properly is a very obscure operation of the overall circuit in which the National part had worked fine. Ultimately I got a hold of the full

schematics of both ICs and upon deeper examination, I found that there was a very slight circuit change in a small part of the RCA design as compared to the National schematic. Not all pin-for-pin parts with equal data sheets are the same!

Bob Swanson: That's why people were happy with an op amp we made 20 years ago and they buy 5,000 a year and the purchasing guy says, "I can save 15 cents a unit," but the engineer says, "I'm not touching it" because he has done the same thing before. He dropped in a 1056 or a 156 and the data sheets were exactly the same but it doesn't work the same. Even today we'll have a complicated product that these guys have tried to figure out how to check all corners of in the analog world and it has to work from zero to infinity; how do you check all those things? We have a part that takes seconds to test several hundred things on a tester, we've breadboarded it and worked with it in the lab and then some customer finds some weird corner where it just doesn't work. Nine times out of ten the customer goes away amazed that we figured out the problem they were having. Sometimes it turns out to be something they were doing and they say that "you guys really know your products."

EDN: You guys have seen semiconductor technology move from the Germanium transistor level to the highly integrated and sophisticated ICs of today.

Bob Swanson: One of your first questions mentioned how some of us were involved in the days when it was Germanium technology, and that was the very first device that I worked on. When I first met Bob (Dobkin) I hardly knew the difference between an amplifier and a voltage regulator. I was the technical featherweight for sure. But I picked up a lot of good insights as to how to make it successful.

Bob Dobkin: When we first started, I had offers from other start-up companies. One of the things about working for a start-up is you don't make ICs by yourself. You need someone whom you can trust to run the company-- and that was Bob (Swanson). You need fab engineers, you need product engineers, so I never even considered going to any of these other companies.

Bob Swanson: Maybe the one last thing is that one of the most important eureka moments that I had at National after I took over the Analog group was to realize these two different strategies that were going on. One group was whittling away at cost, trying to save two-tenths of a cent while they were making millions of TTL gates and flip-flops. As best I could tell, everybody's flip-flops and everybody's gates were exactly the same, so the only way to stay in business was to be cheaper and cheaper. Then I go back and talk to our people who told me that they figured out how they could cut the silicon in half and make the same product or how to add no more silicon but rearrange transistors and make something that was previously worth \$0.75 and now it was worth \$1.50. I realized this innovation thing, though I didn't call it innovation, if you could add value to the top line by doing something smart with no extra silicon and it would be worth another \$0.75! That's so much more exciting to me then to listen to this boring job about how to take two-tenths of a cent out of every gate you make---wow, if we just had a company like that.

Even today, competitors are split that way; those that whittle away at cost to try to stay in the game and those that are committed to innovating---adding that into the top line. We've been

doing it for three decades. If you do that you can base your product on what it's worth and not what it costs or what the next guy is willing to sell his same part for. It's not that it's hard---if you say, "I'll be the innovator," well what can you do better than anybody else? If the answer is "nothing," then you can't be the innovator; you're stuck with whittling away at cost! You need talent.

Bob Dobkin: Not everything you come out with is a big success or a medium success; you have to take a few failures. If you have good guys working on good products ---you're still going to have a lot of success.

Bob Swanson: Smart, happy people probably can be innovators. I tell this story, about five or six years ago somebody asked Steve Jobs (this was when they were going through the roof and they still are!) , you guys are acknowledged to be the best at R&D and innovation and you've got the smallest R&D budget. And he said, 'All you need is a handful of real innovators and you can be successful. And I've got a handful of really good innovators and that's all I need.' So R&D is not an arms race. R&D is about having innovators. Going from 100 engineers to 200 does not automatically double your innovation. If you have 25 innovators and you can get 2 or 3 more a year, you're in good shape.

Bob Dobkin: One way we are unique is that the engineering group comes up with the product ideas. We don't go and do a marketing survey. Our engineers visit customers and figure out new products. We're excited to work on things that the customers want.

Bob Swanson: The engineering group are all businessmen and we've made entrepreneurs out of all of them. So when they present a product, they have to make the case as to why people want it and what people will pay for it and then make a case for what it will cost us and why it all makes good sense. Of course the marketing teams and engineers get out to the customers. If we just stay inside and isolated then we'll miss the next opportunity wave.

Bob Swanson: Some people think we are insular. We don't have leadership here on an ego trip that gets out there in the public eye and speaks at every conference. But the people that make our company run are out there reaching their tentacles everywhere. Our leadership is very focused.

Editor's note: During this interview with these two industry icons, I sensed that they know their place in the industry and in their company and effectively used the talent of their employees in a way that I personally have never seen in my 42 years in electronics. They are strong, talented and intelligent leaders, but with a touch of humility and compassion for their employees from which other companies can learn a great deal. There is a really good book written by two Japanese gentlemen (one of them a Nikkei Electronics editor), which says a great deal about the corporate culture at Linear entitled, "[The Company That No One Leaves](#)." This book gives wonderful insight into one of the key reasons this company has had such success over the last 34 years.

I sincerely wish Bob Swanson and Bob Dobkin many more years of success and I know that someday they will want to retire, but their influence on Linear Technology's corporate culture will carry on to ensure the continued success of their company in the future.

Also see:

[Why no one leaves Linear Technology](#)