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Marki Microwave

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M Ferenc and Christopher Marki

Marki Microwave

Can you tell us about your work experience/ history before founding / working at Marki Microwave?

FM: I've been working in the microwave industry since 1971. I started my career at Watkins Johnson (WJ), where I started, almost from day one, as a mixer designer. I eventually moved on to Avantek, and then Western Microwave where I continued developing new, advanced mixers, especially most of the triple balanced mixers on the market today. In 1991, I started Marki Microwave with the goal of becoming the premier high performance mixer vendor in the world.

CM: Because of my dad's contacts, I was able to take internships at both Lucent and Anritsu while I was still an undergrad at Duke. I decided the avoid entering the real world

Ferenc Marki - President (left)
Christopher Marki - Director of Operations (right)



after college and instead went to UC San Diego to pursue a PhD in Photonics (high speed fiber optics, actually). While at UCSD, I gained

some valuable experience working on DOD projects and consulting for a startup called Ziva Corporation. After 5 years of chasing government

money, though, I realized that my dad had much more to share about engineering and business development than anyone I knew, so the obvious choice was to learn the family business.

What have been some of your influences that have helped you get to where you are today?

FM: There are many talented individuals who have helped me throughout my career. From a mixer designer perspective, two of the most influential and brilliant minds I was inspired by are Bob Maou and Don Neuf (Miteq). Bob and Don's work always pushed me to advance the art of mixer design. Perhaps most importantly, however, is the influence of my wife, and Marki Microwave Vice President, Christine Marki. In the early 90's, Marki Microwave was very small and there was no guarantee that our company would survive. Christine's steady and organized approach to the company finances and procedures were as important to our survival as my understanding of high performance mixers.

CM: Obviously, my dad. Beyond that, though, are my two professors from UCSD: Sadik Esener and Stojan Radic. Sadik taught me how to think about technology development in a way that made me self-reliant. That skill is often under-developed in graduate students because their professors simply give them problems to solve. Sadik made me fend for myself to define my projects, which is invaluable now that I am Director of Operations at Marki Microwave. Stojan Radic is perhaps the more

brilliant experimental scientist I've met. He taught me how to do good science. Stojan always had the right combination of blue sky dreaming with a practical "just get it done" engineering attitude. Beyond that, I think both my father and myself look at Dr. Richard Feynman as the greatest role model for our profession. We both devour any and all Feynman literature...the man was a down to earth genius.

What are your favorite hardware tools that you use?

FM: All of my test equipment. I have boxes that still say "HP" (now Agilent) and "Wiltron" (now Anritsu) on the front. I am an empirical

Don't assume good ideas have already been tried, or simple ideas are too obvious.

scientist, and experiments are how I learn my trade. There is no substitute for high quality test equipment.

CM: The Agilent PNA-X vector network analyzer changed my life. Experiments that once took my dad 20 minutes to setup are now available to me at the click of a mouse. We now have a full measurement suite saved in the PNA-X that can measure almost any mixer metric with great ease compared to the "old school" way of doing it. Of course, my dad refuses to use the box. The other hardware worth its

weight in gold is the "Ecal" module that performs fast calibration of the PNA. I can calibrate the box while I go for coffee...now that's service.

What are your favorite software tools that you use?

FM: I don't use any software tools, just intuition. I don't even have email.

CM: HFSS for 3D simulation work. Microwave Office for schematic work. MATLAB for theoretical work. LabView for test setup automation.

What is the hardest/trickiest bug you have ever fixed?

FM: When I started working on mixers, there was very little literature explaining how mixers actually worked, especially when it came to describing effects like intermodulation distortion, two-tone, and the simple fact that all mixers require a specific LO drive. We had to develop our intuition about the cause and effect in our designs and work tirelessly at the lab bench to achieve better and better performance. People called mixers "black magic" in those days for good reason, they were quite mysterious to even so-called "experts".

CM: I wrote an entire program dedicated to designing ultra-broadband directional couplers in MATLAB. All you have to do is plug in the number of sections, the coupling value, and the coupling ripple, and the program gives you a physical circuit that I then send to the board house for fabrication. During the development, I had to figure out a way to perform a calculation involving a nonlinear set of equations with more than 20 variables. I spent

weeks on the problem, going between MATLAB, MathCad and Mathematica trying to figure out how to do it. I eventually figured out an approach in MATLAB, and the reward was a fully functional, rock solid design program that I still use today for all of my new designs. Last year, I modified the design to make a very bizarre design which was a 6 dB coupler with a 155 degree phase shift from 2-20 GHz...that was hard!

What is on your bookshelf?

FM: I am reading Julian Barbour's work about the concepts of "timeless physics" and Machian dynamics. I have always been interested in people who challenge conventional wisdom, so someone who claims that time is an illusion is worth reading about. As I like to tell my son, "don't accept sacred cows, they will make you a less creative engineer."

CM: Besides physics and engineering text books, very little. My mom would try and make me read more as a child (she's an English teacher), and now my wife does the same. Eventually they will concede that video games are much more fun.

Do you have any tricks up your sleeve?

FM: Yes.

CM: Yes. Marki Microwave does not patent our work, so everything is essentially a trade secret. Suffice to say, any time we call something "proprietary", it is our way of saying "we ain't telling".

What has been your favorite project?

FM: I spent my teens and early 20s as a jeweler, so I always loved designing the mechanical packages for my mixers. The evolution of RF/microwave packaging has always been fun as we started with pin packages and hermetic packages, and then moved on to carriers and then surface mount packages. It seems that every iteration in the packaging evolution brings an interesting new set of problems, and they are always fun to solve.

Most of my former competitors are out of business, or do not develop new mixer technology. Marki is, almost by default, the only viable option for customers who need the highest performance mixers money can buy.

CM: All of the high IP3 mixer work my dad and I perform tends to be very exciting. Our customers seem to have an unquenchable thirst of bandwidth and better mixer linearity. Almost every new design we release is sold within days,

and most of those designs are in some way a world record. When you can release high performance equipment and sell it, that is very satisfying.

Do you have any note-worthy engineering experiences?

FM: Last year, Microwave and RF Magazine inducted me into the "Microwave Hall of Fame". It was gratifying to be recognized for my pioneering work in mixer technology. Since I don't publish articles or patents, and many of my customers work on classified projects, the recognition of my peers in the industry was humbling.

CM: As a 4th year graduate student, I had to take the red eye to Washington DC to visit a DARPA project manager because my professor had fallen ill at the last minute. It was the first time in my life where my knowledge and skills actually had an obvious end game: to produce new technology that people could actual use. It turned out to be a rather innocuous meeting, but it was exciting to see how all those hours in the lab and in the classroom could turn into have some very smart and talented people ask for your expertise.

Do you have an experiential stories you would like to share?

CM: On my 25th birthday, I presented about 6 months of experimental results to my PhD Advisor. I was very proud and thought it would jump start my grad career. At the end of my talk, he says to me, "so what? Why should anyone care". I was very disheartened. I realized after a few days, though,

that my advisor had a point: doing work for the sake of doing work is ok if you are in the pure sciences, but not if you are an engineer. If you don't work on problems that will help people (business people call this "adding value"), then your effort is meaningless. My professor was reminding me that I had to have a good reason for doing countless hours of experiments, otherwise I'm wasting everyone's time and money. A few days later, I buckled down and started writing out the theory behind my work to explain the big picture concept and how the experiments prove certain design constraints of high spectral density fiber networks, for which my first ever paper was published. Always look at the big picture!

What are you currently working on?

FM: New T3 mixers. I have a prototype mixer that covers 10 MHz to 30 GHz, I'm pretty sure that is a world record of some kind. I'm also deeply involved in understanding the impact of local oscillator noise (AM and PM) on high dynamic range frequency conversions. Little literature is available on this topic, and the issue is becoming more relevant for modern systems.

CM: My role is now to oversee most of the new product development. My dad is incredibly productive, so taking his ideas into marketable products is a full time job by itself...the phrase "herding cats" comes to mind. I am also working on new ways of building my dad's original designs that miniaturize the products, and reduce the assembly complexity, which is the primary cost driver. Beyond that, Marki just

released its first line of pseudo-test equipment. The line is called the "Marki Meter" and is an inline power monitor from 10 MHz to 8 GHz. This idea has been kicked around for years, since my days at UCSD, and a good friend who I hired out of UCSD is the lead designer. We look forward to advancing that product line in the coming months and years.

Can you tell us more about Marki Microwave? What are some of the major changes the company has seen since its founding over two decades ago?

FM: Most of my former competitors are out of business, or do not develop new mixer technology. Marki is, almost by default, the only viable option for customers who need the highest performance mixers money can buy. We are in a niche market, so larger companies cannot justify chasing our market because the ROI would not be justifiable. We also have the highest linearity mixers in the world with our T3 line (invented in 2005), and this line represents a complete paradigm shift in mixer technology...it is even obsoleting my own legacy designs. It's always better to obsolete yourself, before your competitor does.

CM: Two decades ago I was still in Little League; I don't play in Little League anymore. Interestingly, many of our employees have been loyal team members to my father since the early 80's. For me, I grew up with many of these people. In that sense, very little has changed.

How large is the company / how many people work at Marki Microwave?

Around 45

What is your work culture like?

CM: I think of Marki as a research group that actually commercializes our work into products. We can't afford the risk of extremely "blue sky" ideas, but we are extremely entrepreneurial in spirit and are always looking to advance the art of our technology. We are addicted to high bandwidth and high performance. Our roots in the Silicon Valley also instill in us a sense of pushing hard for progress and not relaxing on old technology. The RF/Microwave business is sometimes very slow to change. We perform new development work, regardless of if a customer asks first. We are inspired by people like Steve Jobs, who knew what the customer wanted before they knew themselves.

How does Marki Microwave continue to be the premier manufacturer of microwave mixers worldwide, offering the industry's most comprehensive line of signal processing products up to 65 GHz?

FM: We focus on performance first, and cost later. In other words, to make the best, you cannot let artificial barriers like BOM cost and "market data" sway your quest to figure out the limits of your design. Market driven boundary conditions will come up later, after you have figured out what the technical limits are. If you want to be the Mercedes of your niche, you cannot accept the older technology. You must always

innovate on your old ideas. You have to accept the fact that everything we do today is inferior to what we will do tomorrow. If you assume there is a better way, your creativity will help you get there.

Can you tell us about the products lines Marki Microwaves produces?

CM: The main theme is "broadband and high performance". We do not focus on commodity markets like the cell phone or telecom market because we cannot compete. We design and manufacture 100% of our products in the USA, and commodity work almost necessarily requires overseas operations. Most of our products are market leaders in performance, and we are very receptive to custom work. Currently, our top lines are Mixers, Multipliers, Amplifiers, Power Dividers, and Couplers.

About you and your father: Are there any projects you and your father just can not agree on or do not work well together on?

CM: We disagree almost on a daily basis. Since this is science, the disagreements (usually) stay within the lab. I am much more conservative than my dad, who is a maverick thinker. I prefer a more systematic approach while my dad prefers getting his hands dirty. I trust my dad implicitly and almost always differ to his experience, but sometimes I can't help but disagree. Marki males are very excitable (volatile?) people. I can't think of a situation, though, where we didn't ultimately both agree about how to proceed.

What are some of the important life / engineering lessons your father has taught you?

CM: Too many to innumerate. If I pick one, it is simple: "You can't fool Mother Nature". In other words, the most important thing to remember is that you must base your decisions on the technical merit of the argument, not on the

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non-technical noise created by business processes. People believe in many "sacred cows" in science and business, you should question every one of them as a scientist and entrepreneur.

Working with your son, has he taught you anything or brought a different perspective being from a younger generation?

FM: When Christopher started

working here, I tried explaining to him the "grand theory of mixers". I quickly realized that I could not answer many of his questions. He and I are very physical thinkers, and we both did not like the "hand waiving" explanations I was coming up with. He and I began to come to the conclusion that my understanding of certain aspects of mixers was very poorly understood, especially when it came to the physical understanding of how two-tone and IMD are generated. Our early work together forced us to create an entirely new physical understanding of how my T3 mixers work, and this has led to several performance breakthroughs that we never thought were achievable.

Is there anything that you have not accomplished yet, that you have your sights on accomplishing in the near future?

FM: To this day, I have always found our understanding of the noise mechanisms in frequency converters to be unacceptable. Specifically, people consistently blame mixers for causing noise figure degradations in converters, without seeing the system as a whole. Truth is, local oscillator noise (AM and PM) have a dominant impact on mixer noise. While some people know this, few seem to appreciate the fact that almost all the noise mechanisms in mixers make a difference, and the mixer itself (i.e. the diodes) are almost never to blame. This is complicated further by the insufficiency of most test equipment to actually measure noise figure and, more importantly, signal to noise ratio (SNR). It seems to be one of those areas where little

literature exists...someone should get a phd on this topic.

CM: Establish Marki Microwave as a leading brand in products beyond mixers. I would also like to see my dad take a vacation every once in a while, he's twice my age and works twice as much...I feel so lazy.

What can we expect to see from Marki Microwave in the near future?

FM: Whatever it is, it'll be something that you've never seen before. I'm an opportunist, if it makes sense, and the performance is there, I'll figure

out a way of getting the product into my customer's hands.

CM: More T3 mixers. Smaller packages with better performance. The widespread adoption of the Marki Meter product line. Beyond that, it all depends on how creative we can be.

What challenges do you foresee in our industry?

FM: Complacency. An inability to attract younger talent. The over reliance on software design tool in lieu developing one's intuition experimentally.

CM: Most of the young talent going into software instead of hardware. Also, the US needs to streamline the VISA, Green Card and citizenship process for talented, foreign born engineers who want to come to the US.

What advice would you give to new students just getting into the engineering world?

CM: Don't assume good ideas have already been tried, or simple ideas are too obvious. ■

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