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Les Besser, *who is widely regarded as the father of microwave computer-aided-engineering (CAE) software, was a founder of Compact Software. He is currently president of Besser Associates (Los Altos, CA), an organization devoted to continuing education in the high-frequency electronics industry.*

MRF: *How did you get into the high-frequency industry?*

Besser: Thirty years ago, I joined the microwaves division of Hewlett-Packard Co. (Palo Alto, CA) right out of school. I soon discovered that the traditional cut-and-try design techniques did not work at higher frequencies. High-frequency microelectronics were getting into thin-film hybrid microwave integrated circuits (MICs) and I felt that a more scientific method was needed to simulate a circuit's performance before building it. A group of us at Hewlett-Packard created a couple of small programs running on commercial time-sharing systems to analyze our circuits at microwave frequencies.

MRF: *What was the typical time from a concept to an actual prototype back then?*

Besser: It took about three to six months. I remember the first project that I worked on—a broadband amplifier that was used as a preamplifier for the first-generation spectrum analyzer. The complete design phase was six to eight months, something that today could be done in a few days.

MRF: *What did you have in the way of test equipment? Did the HP 8409 exist back then?*

Besser: No. The Vector Volt Meter was built before the first version of a network analyzer came around. When the first network analyzer came, it was quite primitive by today's standards, but it was also quite exciting. I recognized the importance of scattering (S)-parameters and talked with our division manager, Paul Ely, about the need for educating other engineers about this. He agreed that two or three of us would go around the country to give seminars on S-parameters. I really believe that these educational efforts helped Hewlett-Packard gain acceptance for S-parameters, which, in turn, led to the sale of network analyzers.

MRF: *Were engineers unwilling to think that such an instrument would work at first?*

Besser: Yes, this is true. I will never forget when we were at a company in Long Island, NY giving a seminar on the first network analyzer that we had with us. A man in the back was standing with his arms folded and he appeared very disbelieving. He put up his hand and asked whether he could really trust the data he would get from measurements on a high-frequency transistor. I told him yes, that is all you need. He then queried that if he were to come back the following day and make the same measurements, would he get the same answers. When I replied yes, he called us liars and stormed out of the room.

MRF: *How did you become interested in software?*

Besser: Basically through my own design needs. Because there was nothing available commercially in those days, we had to write our own software and work the simulation of the circuits. To make things worse, the software programming languages were very primitive and there was no complex or matrix al-

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gebra. Commercial time sharing, where you could access a large computer through a terminal, was a real shot in the arm because many of our in-house machines were difficult to operate.

MRF: *What were the capabilities of that early code?*

Besser: The early program allowed two-port interconnections of one- and two-port circuit elements. It was written for simulation but not optimization of series and parallel cascaded connections.

MRF: *How did your journeys take you from Hewlett-Packard to Compact Engineering?*

Besser: I actually left HP for another job at Fairchild. While at Fairchild, when I was working on my graduate degree in electrical engineering, I wrote a program at school for the university's model 1130 IBM computer. Later, I converted that program to something I could use over commercial time sharing, which was applied at my next job at Farinon for our design work. By that time, the program had more features and capabilities than the original code, and it also included optimization. The program by then had become my life—day, night, and every free minute that I had.

I worked on the program for several years, developing it on time-sharing computers where I was getting royalties for its use. I realized I was spending as much time on the development, maintenance, and modification of the program as I was on my demanding full-time job. It became clear that I could not maintain the program and the job at Farinon while also having a family life. So I took a leave of absence from Farinon, did some market research, and, with Bill Farinon's blessing, started Compact Engineering in 1976.

MRF: *Was there resistance in using software for design back then?*

Besser: Yes, there was very strong resistance from design engineers. In many cases, people had to see actual examples. For this reason, I started a series of courses at UCLA and some other schools to convince designers that the software does work. I published as much of this work as possible to support the claims of the program.

MRF: *How did COMSAT become involved?*

Besser: I was getting worried by the late 1970s because market projections claimed that office automation would be the next big thing in the 1980s and it would become a multibillion-dollar market. Big companies would get into this and I was afraid that there would be little hope for small companies such as mine. When COMSAT approached us because they wanted to diversify and form a new group to get into office automation, it made sense to work with them. Our relationship eventually lead to a merger, forming COMSAT General Integrated Systems (CGIS) in California.

MRF: *How big was Compact Engineering at that time?*

Besser: At the time when we started to work with COMSAT, there were eight or nine of us. By the time we actually merged with COMSAT, about nine months later, we were up to 15 people, with annual revenues of $1.5 million.

MRF: *Did you support IBM computers at that time?*

Besser: This was a sore issue. I wasn't a professional programmer and the first interactive program was really written for the specific time-sharing system that I originally operated on. The first in-house installation was for Communications Research Center (CRC) in Canada in 1976, and their programmer was just outraged by all the "fundamental programming" violations that he had found in the program. To make things worse, every computer and every operating system at that time was different. We had to maintain source codes for every program that we sold. We did sell the source code because that was the only way we could sell the software, but every version had to be modified to suit a particular customer's system. As a result, we had a huge room full of the latest codes of every operating system—maintenance was just incredible.

When we merged with COMSAT, we decided that we were going to put all of the different codes on a VAX 1170 minicomputer and that it might be a good time to rewrite the program. This is how the SuperCompact program was created. We figured that anyone who wanted to use the program would have to use a VAX. Well, a few days after that, an executive from Hughes Aircraft Co. (Torrance, CA) called me to say that they use the IBM system and since they were one of the most important defense contractors, we would have to convert our program to the IBM. So we made an exception. Then Rockwell needed a version, then the US Navy did, and so forth. Soon we had quite a few versions again. But we were smart enough to learn about software switches and modularity so that we were able to meet many different needs with one main software code.

MRF: *When did you get out of the arrangement with COMSAT?*

Besser: I had some personal difficulties from 1982 to 1983. I stepped down from the operation and became a consultant. Shortly thereafter, one of our key employees also left and soon EEsof (Westlake Village, CA) was formed. By the mid-1980s, COMSAT became frustrated with this group of programmers, closed the company, and sold off the capital equipment and software.

MRF: *When you saw what Bill Childs and Chuck Abronson did with EEsof, creating design software for the personal computer, did you ever have any regrets about getting out when you did?*

Besser: Yes, absolutely. If I knew what IBM was planning with their entry into the personal-computer marketplace, I would not have sold the company. There were some people who advised me not to do so anyway. The personal computer brought all programmers a level of acceptance that I could not achieve on larger computers. As an example, I tried for years to sell SuperCompact on minicomputers to Avantek (Santa Clara, CA) and could not. As soon as EEsof had Touchstone on the personal computer, Avantek bought a

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large number of copies, spending close to the amount we asked for our program. It was much easier to justify individual purchases of Touchstone for different personal computers than the purchase of a large computer and a multi-user program.

MRF: *You did make a wise choice to get into education, since there is a continuing need in this industry. How did you get started in the educational business?*

Besser: My employment contract with COMSAT prevented me from getting back into the software business. Education was the next logical thing for me after software. This was really a continuation of the work that I had started at UCLA. The videotaped courses were put together as refresher courses for those who had taken earlier courses and could not take in everything. They could view them at their own pace and in their own time or, in the case of those who could not get to a course, it was a convenient way to further one's education. In reality, however, there is no replacement for live instruction with student-teacher interaction.

MRF: *Are there differences in the way you teach courses today compared to those earlier courses?*

Besser: Well, there are several areas where they differ. One obvious one is in the frequency range going from the gigahertz range that the military users required to the megahertz range to satisfy the needs of commercial communications designers. Another area is a switch from transmission-line circuits to lumped-element circuits. Too many people have felt that if it was possible to design something at 12 GHz, it should be much easier to design something at 900 MHz. As a result, they totally underestimated the problems in designing RF circuits for high-volume, low-cost applications.

MRF: *In the 10 years that you've been teaching RF fundamentals, do you see a difference in the type of students that you are addressing?*

Besser: Yes, and this is true not just in the US but in Europe as well. Other lecturers and I see a decline in the general educational level of our students. When questions were asked 10 years ago, we received many answers. Today we get many blank stares.

MRF: *Is this because students with digital backgrounds are entering the RF area?*

Besser: That is true, but we also still have people with many years of experience who really do not understand some of the fundamentals. There are a lot of myths out there that are misleading and some basic issues that are not understood.

MRF: *How have you developed your courses over the years?*

Besser: We talked to customers and found out what they needed. A couple of areas were obvious. While there were courses for higher-level engineers, there were very little for production types. These people face real challenges because they don't have the knowledge about specific products, they don't have the time, and they don't have the detailed understanding of how circuitry works, but they are expected to produce poorly-designed circuits quickly. As a result, the RF Productivity course was developed for these people. The Wireless Made Simple course was developed to help managers, marketing people, and sales people get a better understanding of state-of-the-art technology without getting bogged down with mathematics and theory.

MRF: *How did the course on SPICE come about?*

Besser: SPICE is such a universal tool that it has become essential to designers throughout the industry. Many people had some introduction to SPICE in college, but it was usually superficial, applying only to specific circuits. We felt that this tool needs to be explored deeper, so we put together a course that helps students to fully understand and use SPICE.

MRF: *How does Besser Associates work to give courses within individual companies?*

Besser: We generally start off from the central training organization and then filter down to specific divisions, modifying our general courses to fit their needs. We have extremely good relationships with several large corporations, where we provide their RF educational needs.

MRF: *How has the move to wireless communications affected the kinds of education that you provide?*

Besser: It is no longer enough to understand analog design techniques. Today, a good designer must be familiar with analog as well as digital design. It is not enough to understand component circuitry; there must be understanding about integrated circuits and system-level concepts, and some understanding about device physics. The need to be a real specialist is disappearing; we will face more and more of the generalist type of designer who can understand everything. This puts a great strain on an engineer, who must get the knowledge in all of these different areas. This is where CAE is really helpful. I am still amazed, however, when I walk around a classroom and ask how many people use RF or microwave CAE tools and no more than 30 or 35 percent put up their hands. This means that two thirds of them are still back in the 1950s and 1960s.

MRF: *Are there any new CAE developments that you are excited about?*

Besser: Nonlinear active device modeling, statistical yield optimization, and electromagnetic simulation are gradually becoming more practical. Although many people still view these techniques as too abstract and too mathematical, there are enough success stories around to create credibility. As for the future, artificial intelligence and genetic modeling will play an increasing role in circuit and system design.

MRF: *Is this a good time to be an RF engineer?*

Besser: Yes, it is definitely a good time. I see the demand and I think a good RF engineer has a tremendous future. Being an RF engineer also brings a wide range of expectations, however, with a lot of pressure because that person must understand a wide range of topics and have a wide range of knowledge. ••