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An Interview with Dr. Zoltan Cendes

MRF: What led you to start Ansoft?

Cendes: I started Ansoft in 1984 while I was a professor at Carnegie Mellon University conducting research. Some of our research partners were asking us to produce commercial software tools in addition to the continuing research they traditionally funded us to perform, so we began to satisfy their requests.

MRF: What was Ansoft's first product?

Cendes: We called it Eddy. It was a two-dimensional program for computing eddy currents in AC conductors. We followed that effort with some simple two-dimensional microwave simulation programs. Soon thereafter, Hewlett-Packard Co. asked Ansoft to develop a three-dimensional finite-element simulator that they would sell, having been asked by their customers for alternatives to test-and-measurement instrumentation to speed the product-development process. We were obviously excited about the opportunity, and it contributed heavily to our expansion into higher-frequency design.

At that time, solving high-frequency electromagnetic problems using finite elements often resulted in unphysical spurious modes. This was a severe limitation, and presented us with a great challenge. We invented procedures to avoid these problems, which made it possible to solve three-dimensional electromagnetic field problems using finite elements for the first time.

MRF: What was the result of the work for HP?

Cendes: The culmination of our work was the software program HFSS, which was the first commercial program that could simulate complex three-dimensional geometries. After we finished the initial software development, HP marketed the product exclusively for us. We began shipping the product in 1990, and it has since become the industry standard for three-dimensional, electromagnetic field simulation.

HFSS continues to be one of our core products, but of course it's much faster now—15,000 times faster than in 1990. With greater speed, an ability to address open-region problems and create full-wave SPICE models, HFSS is utilized by designers simulating complex antenna structures, optical-communications systems, RF ICs, high-speed PCBs and connectors, and biomedical applications. Perhaps the most significant change is in optimization and sensitivity analysis, where you can now synthesize improvements by specifying design goals and simultaneously investigating manufacturing changes to reduce costs.

MRF: The Ansoft/HP (now Agilent Technologies) partnership came to an end in the mid 1990s. What happened?

Cendes: We parted ways with HP about six years ago, basically because our views of HFSS development differed. However, we both continued to develop HFSS products, and now Agilent has agreed that our HFSS technology is best, and they have sold their HFSS business to us. We are working with them to transition their customers to Ansoft solutions. HP (now Agilent) was key to the early development of our company, and we're happy we'll be working together again.

MRF: What is the significance of your Full-Wave Simulation Program with Integrated-Circuit Emphasis (SPICE) product?

Cendes: Full-Wave SPICE is a unique functionality that addresses one of

the key areas that high-speed digital designers have struggled with during the past several years. As frequencies have approached and gone into the realm of RF, digital designers face new problems. SPICE, the main tool for circuit designers, does a poor job of handling high-frequency effects. However, using Ansoft's Full-Wave SPICE, digital designers can model the true physics in their transient SPICE circuit simulation—without resorting to either inaccurate single-frequency models or trial and error. Full-Wave SPICE automates the entire process and produces frequency-dependent SPICE models in Hspice, Pspice, or Maxwell SPICE formats, so that designers can continue to work with tools they are familiar with, and obtain the accuracy they need to address today's speeds.

MRF: What has been the obstacle to solving this problem?

Cendes: Traditional circuit models miss much of the physics and are best used for low-frequency circuits and for components that are small compared to wavelength. Designs for higher frequencies must account for electromagnetic interactions. If you solely rely on circuit-level models, the first iteration of a design will most likely not deliver the desired performance. This means you have to create a lengthy cycle of prototypes to achieve your goals.

MRF: You have described Ansoft Designer, which debuts next year, as one of the major benchmarks in your company's history. Why is this so?

Cendes: Ansoft Designer is a benchmark for Ansoft and a major step forward for the industry. It represents the next generation of design tools that integrate different levels of simulation technology, allowing the user to customize the level of accuracy needed at all phases of the design process. Our "solver on demand" architecture will greatly simplify the optimization process, making it far easier for engineers to make tough design decisions early in the process, and avoid surprises downstream.

For example, if you are solving a complicated circuit using components for which there is no model, Ansoft

Designer will call the electromagnetic simulator on demand to perform the required simulation. Until now, people needed to rely on multiple tools and troublesome translators, and go back and forth trying to analyze the design. Designer lets you work all levels, simultaneously, without burdening the user with additional steps. This approach simplifies the process without constraining a designer's creativity, and the modern user interface makes it easy to learn.

MRF: What do you feel are the broad trends in design tools?

Cendes: The Holy Grail has always been simulation software that is reliable, highly accurate, easy to use, and robust so a broad spectrum of problems can be solved. However, it is a mistake for EDA vendors to believe they can make something very simple and yet highly versatile. There are always trade-offs. Our customers tell us that they want high accuracy—it's why they buy simulation in the first place. Next, they need the power to customize and tune our tools to their environment.

Finally, and just as important, no solution is complete without knowledgeable, responsive people to help designers apply these tools. It's often our applications people that see the next innovation, from their experience with customers using the tool. Service is often the key differentiator and it's the area that many simulation companies completely overlook or gravely understaff. I am proud of our commitment to service. I frequently receive accolades from our customers when I visit the MTT and DAC conference.

MRF: What are the challenges you face in achieving this goal?

Cendes: There are two parallel paths creating the ultimate solution. The first is the algorithm itself—every year we invent better algorithms that will give more accurate answers faster and can handle larger problems. The next level is the user interface, which we continually improve with customer feedback. Within the software level, many improvements are made in quality that the user never sees, but experiences indirectly in terms of superior performance, fewer

inconsistencies, and better operation. I remember writing in FORTRAN, and how constrained that was. With the object-oriented programming that we have been using since 1988, we can create software structures that accommodate more sophisticated programming and better code more efficiently. Both of these paths are evolving every year, and they will continue to inch closer to an ideal solution.

MRF: How much is your development work driven by, or perhaps limited by, computer hardware?

Cendes: In our early days with HFSS, around 1990, our abilities really were dictated by the performance of the computer hardware. However, at about that time, workstation performance really began to accelerate without an increase in cost. That let us finally solve three-dimensional problems without incurring high additional costs.

As an example, one of our original test problems with HFSS was to develop a waveguide-to-coax adapter. This simple structure took 16 hours to solve on a Sun 4 workstation. Today we can solve the same problem in 20 seconds. Of course, some of that speed increase is attributable to hardware performance, but we continuously increase the performance of the software as well. On average, we have more than doubled the speed of our algorithms every year.

MRF: Are there problems that still require a workstation to solve?

Cendes: It's hard to say. Every time we reach a new level regarding the problem size we can solve, customers ask for more. Although PC performance has narrowed the gap, and can solve a great many problems, today's workstations have 64-B operating systems that allow almost limitless amounts of memory.

However, I believe customers will continue to push the limit, and there will always be a need for varying levels of computer performance. I'm quite certain that we haven't yet seen all the innovations of our time, and that hardware vendors will work hard to keep a differentiation that is valuable to the marketplace.

MRF: Are there limitations to current high-frequency design software? Are there problems these tools still cannot solve?

Cendes: There are still significant challenges for our industry. The one that generates the most attention is tackling larger and larger RF ICs with thousands of transistors. Standard harmonic balance engines cannot handle very large structures, and while you can solve some in the time domain, the results are not very accurate. Traditional circuit-design tools for standard ICs address the larger structures, but not the microwave characteristics. Microwave tools cannot handle the level of complexity, as can standard IC design tools. We're working in from both ends of this technology to solve this problem.

Another challenge is in the realm of electromagnetic and circuit simulation. They can be done in cosimulation, but the electromagnetic part is still only working on a smaller portion of a device

or circuit. If you simulate a whole device or board, it can be overwhelming for pure electromagnetic simulators. Our goal is to analyze the whole board with electromagnetic accuracy. I already see progress in handling much larger non-linear circuits with harmonic balance, and in quickly doing much larger boards with many devices.

The technology incorporated into the Ensemble planar simulator, SVD Fast Solve, has allowed us to speed up full-wave simulation with planar structures by an order of magnitude.

MRF: Do you have any final thoughts on the direction of the high-frequency electronic-design-automation (EDA) industry?

Cendes: This is a very exciting time in high-frequency design automation. I started Ansoft with the vision to leverage the power of electromagnetics across component-, circuit-, and system-level design. Today, we are the recognized

world leader in this area. By providing total solutions with circuit- and system-level models derived from accurate electromagnetic models, our tools replace long and expensive build-and-test cycles with fast and economical computer simulations. As more designs move to ever-higher frequencies, to millimeter-waves and to optics, the need for our solutions exponentially increase. Traditional methods no longer work well. Customer hunger for greater speed, greater density, longer battery life, and improved functionality is driving virtually every technology company, regardless of market. Ansoft is qualified to serve these needs, with our expert personnel and our pioneering work in creating products to serve this market. We have only just begun. I find the new world of high-frequency design very exciting, and can hardly wait to see the revolution in high-speed digital, RF, microwave, and optical products that will result. **MRF**