

Newsletter of the Center for Ethics and Entrepreneurship at Rockford University

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FEATURE Zol Cendes Entrepreneurship and Software

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INTRODUCTION:

Dr. Zoltan Cendes was the co-founder, chairman and chief technology officer of Ansoft Corporation, now part of ANSYS. Prior to founding Ansoft, Mr. Cendes received his undergraduate degree at the University of Michigan and his M.S. and Ph.D. degrees from McGill University in Montreal, Canada. He was then an engineer with General Electric in Schenectady, New York, associate professor of engineering at McGill, and professor at Carnegie Mellon University in Pittsburgh, Pennsylvania. For his achievements in developing software tools for electromagnetic analysis and design, he received the Antennas and Propagation Society Distinguished Achievement Award.



Kaizen: You were a founder and chairman of Ansoft, whose mission is developing software?

Cendes: That's correct. In 1984 I was a professor at Carnegie Mellon University (CMU) performing research in computer simulation technology. I was approached by a member of the research staff at Alcoa to develop a computer program to model electromagnetic casting. At the time, molten aluminum was poured through mold and cooled to form ingots. Alcoa wanted to develop a process where the aluminum was supported through the molten column by an electromagnetic field rather than by a mold. In this way, the aluminum would form better ingots since it was cooled without touching it. I proposed to Alcoa that I recruit a graduate student to perform research in this area. Alcoa replied that they didn't want to fund research-they wanted me to start a company and develop a commercial software program that they could

use in their own design process. I started Ansoft Corporation with the initial funding from Alcoa, developed our first software program to simulate the electromagnetic casting of aluminum ingots. In subsequent years we expanded our simulation capabilities to address thousands of other products in electrical and computer engineering and grew Ansoft to a company worth \$900 million.

Kaizen: Ansoft is now part of ANSYS, a \$7 billion corporation, but it's not a company that most of us know about. What does it do?

Cendes: ANSYS is the leading company in the engineering simulation market. It develops software used by engineers as an aid to design and development better products. Consider the cell phone in your pocket. There are literally billions of components in this cell phone. It is impossible for anyone to understand all of the interactions



From the Executive Director

A study shows that Stanford University alumni create nearly \$3 trillion in economic impact each year, and companies founded have created 5.4 million jobs. Stanford stands as a model of how first-rate research and teaching can have win-win impact on the larger world outside the academy.

So it is appropriate that our feature interview is with former academic Zoltan Cendes. Mr. Cendes was a faculty member at McGill and Carnegie-Mellon before leaving to start an enormously-successful engineering software company. I spoke with Mr. Cendes in Naples, Florida, about his life and career, which began in Hungary, involved time at a war-refugee camp in Austria and hardship growing up in Canada, before he achieved academic and entrepreneurial success.

In this issue of *Kaizen*, we also report on guest speakers John Chisholm and Robert Lawson, who visited us from San Francisco and Dallas, respectively, and the excellent work of two students in the Business and Economic Ethics course—Amour Muro and Alex Patnou.

All of our previous issues of *Kaizen* are available there featuring our news and extended interviews with entrepreneurs in a wide variety of exciting fields—from architecture to technology to marketing to venture capital to sports and more. Please feel welcome to visit us online at www.EthicsandEntrepreneurship.org.

Stephen Hicks, Ph.D.

ZOL CENDES CONTINUED

among these components without using simulation software. Or consider the car you drive. Engineers use simulation software to determine the mechanical integrity of the components, the efficiency of the combustion in the cylinders, the forces due to airflow around the car, the interactions of the electrical components in the car, and thousands of other concerns.

Fifty years ago, products were designed by trial and error—engineers and designers would build a prototype of the product and test it to see if it worked. Today, simulation driven product development is the norm; most of the products you buy and use today—from computers to airplanes to medical devices—are designed using engineering simulation software.

Kaizen: Where did you grow up?

Cendes: My background is diverse. I was born in a Displaced Person's Camp in Austria of Hungarian parents. We immigrated to Canada when I was three. We were deposited on a farm in October in the middle nowhere with no money, no food, no car, or anything. My father, who had two Ph.D. degrees but spoke no English, found a job in a automobile parts factory where he worked for several years. I grew up very poor with periods of hunger and deprivation. However, I always knew that life was full of possibilities. My father eventually became a Math Professor, first in Canada and then in the USA at Central Michigan University. My desire for learning was fostered by my parents who understood the importance of intellectual achievement.

Kaizen: Were you technically-oriented as a youth?

Cendes: Yes. One of my earliest memories is drawing pictures of rockets going to the moon when I was perhaps four years old. Growing up I loved to read books about rockets and all things scientific. I loved to build things with my Erector set, and built a telescope and electrical devices as a teenager. I was always fascinated by the world, wanted to understand it, and dreamed of inventing something that would change the world.

Kaizen: What led you to choose engineering as your undergraduate major? **Cendes:** My path to engineering was not a straight line. As a youth, I was fascinated by physics and as an undergraduate drifted between taking engineering courses and physics courses. I actually began my Master's study in the physics department at McGill University but was assigned a boring Master's project. Looking around, I discovered groundbreaking research being performed by Professor Peter Silvester in the Electrical Engineering Department at McGill. Professor Silvester's work was cutting edge. I switched departments to Electrical Engineering and never looked back.

Kaizen: What were you thinking your likely career path would be?

Cendes: As a youth, I did not know what my career path would be except that it would involve understanding how the world works. Once I encountered Professor Silvester, I fixed my chosen area of study and supposed I'd be an academic the rest of my life.

Kaizen: You then got master's and doctoral degrees in electrical engineering from McGill. What was the focus of your doctoral work?

Cendes: My thesis advisor, Professor Silvester, was a pioneer in applying computer methods to simulate electromagnetic fields. Let me begin by saying that electromagnetic fields are one of the most fundamental quantities in nature. There are only four known forces in the universe-gravity, electromagnetics, and the strong and the weak nuclear forces. Electromagnetic fields are at the heart of all electrical engineering and, indeed, much of your life. The equations describing electromagnetic fields were discovered by James Clerk Maxwell in 1864 and describe macroscopic electromagnetic phenomena perfectly and completely. However, these equations are very difficult to solve except in the simplest of circumstances. My doctoral thesis was to solve Maxwell's equations in more complex, real-life cases using a new computer simulation technique called the finite element method.

Kaizen: After that you became a professor? **Cendes**: No, I first went to work at the General Electric Company in Schenectady, New York, first in the Large Steam-Turbine Generator Division and then in the GE Corporate Research and Development Center. At GE, I developed computer programs to simulate the behavior of electric power transformers and generators. Using the finite element method to compute the electromagnetic fields inside transformers and generators provides a much higher level of knowledge about transformer or generator performance than can be obtained by measurements alone.

At one point, I received a letter from the Vice President of GE's Transformer Division stating that by designing more efficient transformers our software simulations had saved the company over one million dollars during the past year.

Kaizen: What motivated you to leave GE and become a professor?

Cendes: Professor Silvester asked me to return to McGill as a professor. The offer was very appealing because being a professor is much more entrepreneurial than working in a large corporation. While GE was an excellent place to work, it still had a large bureaucracy. A good professor is a mini-CEO—he is self-starting, sets his own direction, assembles a team of students, raises his own funding and achieves goals. I went to McGill and started teaching and doing research. Two years later, I received an even better offer from Carnegie Mellon University in Pittsburgh, Pennsylvania, and moved there.

Kaizen: You started Ansoft in 1984. Why did you decide to go entrepreneurial rather than remaining a professor?

Cendes: There were several reasons. I had always wanted to be an entrepreneur— Ansoft was third company I had started. And there was the nudge by Alcoa. But, beyond that, commercializing the research in computer simulation technology was in the air at that time. Several other professors, including my advisor Peter Silvester, started electromagnetic field simulation software companies at that time. I was fortunate to be working in this field at the dawn of a new industry.

Kaizen: Your specific challenge was to develop software to solve Maxwell's equations. What does that mean, in layman's terms?

Cendes: As I mentioned earlier, Maxwell's equations describe electromagnetics perfectly but they are very difficult to solve in real-life situations. The difficulty lies in the complex interactions that exist between fields in three-dimensional (3D) geome-

CEE NEWS

CEE Essay Contest Winners:





Alex Patnou

Students in the Business and Economic Ethics course wrote on the topic: *What does success in business require?*

The essays were judged on their accuracy and depth of interpretation as well as their independence of thought. A cash prize was awarded to the contest winners. Congratulations to our winners!

Guest Speakers: John Chisholm and Robert Lawson



San Francisco's John Chisholm, a Silicon Valley entrepreneur, gave a talk entitled "Unleash Your Inner Company." He spoke about the values that motivate entrepreneurs, his own entrepreneurial experiences, the similarities and differences between companies such as Apple, H–P, and IBM, and the ethics of entrepreneurship.



Professor Robert Lawson of Southern Methodist University spoke at Rockford University on the Economic Freedom of the World Index, which measures various dimensions of economic freedom—contractual rights, labor mobility, property rights, and so on—and the relationship between economic freedom and other values such as civil rights, life expectancy, and environmental health.



ANSYS 3D electromagnetic field simulation

ZOL CENDES, CONTINUED

tries. The finite element method on which I had worked on my dissertation solves this problem by breaking the geometry into a myriad of little pieces called finite elements. Maxwell's equations are approximated over each finite element and the entire problem solved by assembling and computing all of the interactions on a computer.

Kaizen: What were the technical challenges in doing this from a commercial point of view?

Cendes: There were two principle technical challenges. The first came from the need to automate finite element mesh generation—the process of breaking complex 3D geometries into little pieces. At GE, we had developed specific programs to generate finite element meshes for individual transformer or generator geometries. However, commercial software needs to be flexible—the program designer has no idea of the geometries customers wish to solve. So we developed new algorithms to automatically subdivide any geometry into a finite element mesh.

The second challenge was the nature of the finite element approximation itself. It turned out that the standard finite element process developed by mathematicians earlier gave incorrect results in many situations. We invented new types of finite elements called edge elements that solve Maxwell's equations correctly. The combination of automatic mesh generation and reliable electromagnetic solutions propelled Ansoft to lead in the electromagnetic field simulation industry.

Kaizen: Where were you geographically at this point?

Cendes: I was still in Pittsburgh at the time. I resigned my tenured professorship at CMU in 1996—the year Ansoft went public.

Kaizen: You had a co-founder. Who was that?

Cendes: There were two co-founders my brother Nick and his business partner Tom Miller.

Kaizen: What was the division of labor among you?

Cendes: Nick and Tom had business backgrounds so they were focused on administration, finances, and investor relations. I was focused developing the technology, products and markets.

Kaizen: How much capital did it take to develop and launch Ansoft, and what sources of funding were you using?

Cendes: Ansoft grew organically. In addition to our first funding from Alcoa, we received contracts from such companies as Kodak and Amp totaling over a million dollars. We also began to get revenue from software sales but this varied from around \$10,000 to \$50,000 a month in the early years.

"A START-UP COMPANY IS THE MOST FUN PLACE TO WORK IMAGINABLE."

Fortunately, the capital expense in launching a software company was small. We bought a couple of personal computers with the initial Alcoa money. The biggest expense was salaries. Because sales and contract revenues were erratic in the early years, some months Nick, Tom and I would have to borrow money on our personal accounts to meet payroll. In our fifth year, we did receive \$500,000 from a venture capital firm, but this was a relatively small addition to the revenue we made by that time.

Kaizen: Did you have any early difficulties with the developing the software?

Cendes: A start-up company has a million difficulties. All of the people we hired were straight out of school, assignments were fluid and flexible, and everyone was jockeying for position and authority. At the time, personal computers had 640 kilobytes of memory—literally a million times less than a computer used to solve some engineering problems today—and there was no graphical user interface. We had to work around these and many other limitations.

Nevertheless, a start-up company is the most fun place to work imaginable. Every day is filled with challenges and adventures and each person can make significant contributions to the success of the organization.

Kaizen: Any special challenges marketing Ansoft's software?

Cendes: Ansoft entered a quintessential "blue ocean" market in which there were few competitors. We were pioneers in an entirely new landscape in which electromagnetic problems could be solved for the first time. A few visionary customers understood our value proposition and purchased the software readily.

More often than not, however, we faced a "missionary sale" in which we needed to convert the customer from his reliance on the old way of doing things to the new. It took a lot of effort in the early years to convince engineers that computer simulation of electromagnetic fields was real and that they could save thousands of dollars by buying our software instead of building prototypes.

Kaizen: A big step for Ansoft was a connection with Hewlett-Packard in 1989. How did that come about?

Cendes: Ansoft's agreement with the Hewlett-Packard Corporation was the best thing that ever happened to us—and the most harrowing thing that ever happened to us. HP approached us in 1988 about developing an electromagnetic simulation software program for them to sell to microwave engineers. In the resulting OEM agreement, Ansoft would develop a program called HFSS for use by microwave engineers, HP would sell the software, and Ansoft would get a royalty on every copy sold. HP gave Ansoft a \$325,000 advance on royalties to enable us to develop the product.

We were ecstatic. At that time we were a small, inexperienced company with zero marketing and sales force. HP was a large, top-of-the-line company with thousands of sales people around the world. We went to work feverishly and had everyone in Ansoft developing the product. The only



ANSYS simulations used to test drag reducing Speedo Fastskin3 cap, worn in the 2012 Olympics by Michael Phelps and others

problem was: HP's standards were much higher than I had anticipated. Product shipment was delayed by over a year. We burned through the royalty advance and were running on vapors. Finally, HP shipped HFSS in October 1990.

Of course, our initial royalty revenues were cut because we had to repay the royalty advance. And HFSS sales were below forecast initially as well. We were running out of money, and HP approached us with an offer to buy the company at a very low price. I am aware of two other microwave software companies that HP bought in this way. They too had developed software for HP using royalty advances and sold out to HP when their finances dried up. Fortunately I had put an escape clause into the HP agreement. HP wanted us to develop software for microwave engineers but I suggested that we develop software for antenna engineers as well. HP said no, that their initial interest was for the microwave market only, and so I added a clause into the agreement specifically excluding software for antenna design.

Fortunately, HP didn't realize that with the simulation technology we were using, microwave design was a subset of antenna design. So we added antenna capabilities to HFSS and were allowed under the agreement to sell this improved, more capable product. The long and short of it is that we were able to generate a secondary revenue steam and started prospering. If I had not inserted the exclusion of antenna simulation software into the Ansoft-HP agreement, Ansoft would have become a small part of HP and you wouldn't be talking to me today.

Kaizen: When you started Ansoft, how many people were involved?

Cendes: In the first year we had 5 people but this grew to around 25 in five years. Our growth was constant—our revenue and our personnel grew at roughly 30% year after year for many years.

Kaizen: And by 2008, how many people were working at Ansoft?

Cendes: Approximately 300—roughly 200 in the USA and 100 around the world. An interesting aspect of modern technology is its international nature. We had direct sales and support offices in twelve countries. While we were a small company, we used to joke that the sun never sets on "the Ansoft empire."

"MANAGEMENT SKILLS ARE LARGELY THE SAME AS INTER-PERSONAL SKILLS."

Kaizen: As Ansoft grew you became the head of a much bigger organization, which brings with it new management challenges. Did developing the necessary management skills come naturally, or was it something you had to work at?

Cendes: I believe that management skills are largely the same as interpersonal skills. You have to be aware of people's strengths and weaknesses as well as their wants and needs. If you care about the people in the organization, and judge their abilities correctly, it is natural to grow an innovative, dynamic organization.

People who joined Ansoft were coming to a new, high-tech company that was changing the way electrical engineering was done. They were highly motivated and self-starting. Due to my academic background, we fostered an open, looselystructured environment where every employee possessed a great deal of freedom and responsibility.

Kaizen: You took Ansoft public in 1996. What goes into that process?

Cendes: The universe of high finance and the universe of academic engineers couldn't be more different. In the IPO, the investment backers took us around in limousines to expensive offices in New York and other financial centers; as an academic, I was more used to the lower end of travel arrangements.

In the IPO, I was giving talks to one or two financers at a time, avoiding the use of equations (although I did have one slide showing Maxwell's equations), and talking about industry trends; at academic conferences, my talks would contain lots of equations and engineering detail. As everyone knows, the uncertainty in business plans is high; an engineering paper presents definitive results.

To illustrate this point, our investment banker had just before us taken a company public called *Legends of the Past*—a company with Marilyn Monroe and Elvis Presley impersonators, among others. You can imagine that presenting the Ansoft story to an investor who has previously heard a pitch from *Legends of the Past* is different than presenting it to engineers.

Kaizen: Ansoft had been very successful, and that led to a merger with or sale to ANSYS in 2008?

Cendes: Yes. Interestingly, both Ansoft and ANSYS were headquartered in Pitts-

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ANSYS software simulation used for optimizing a Ferrari 's aerodynamic performance

ZOL CENDES, CONTINUED

burgh and both Ansoft and ANSYS have similar names—Ansoft is an abbreviation of Analysis Software while ANSYS of Analysis System.

Kaizen: At that point, Ansoft was the world's leading company in is field. By what criteria does one measure that? Revenues? Market share?

Cendes: Our revenue was over \$100 million at the time. A number of smaller companies had entered the market but their combined revenue was less than ours. Similarly in market share—almost every Fortune 500 company in the electrical engineering space was using our software; much fewer were using our competitors' software.

Kaizen: How did the merger process start—who approached whom?

Cendes: ANSYS approached us. ANSYS had started earlier than Ansoft, they were in the mechanical engineering design space, and were significantly larger. ANSYS wanted to round out their engineering design offerings by adding electrical engineering products to their existing mechanical engineering products.

Kaizen: How much was Ansoft valued at for the merger, if I may ask?

Cendes: When the deal closed on August 1, 2008, the combined cash and stock valuation was around \$900 million.

Kaizen: What are the major factors going into determining the valuation?

Cendes: Since Ansoft was a public company, determining the valuation was relatively easy—ANSYS simply put a 15% premium on our existing stock price. *Kaizen*: Was it difficult to decide whether to stay on with the to-be-merged companies or to leave?

Cendes: Yes. Ansoft had become a large part of my life and I regretted leaving it. On the other hand, the merger of Ansoft and ANSYS made a lot of business sense and I realized my role there couldn't continue.

Kaizen: Was a non-compete agreement part of the merger deal?

Cendes: Yes. However, the merger agreement didn't include any "golden handcuffs," so I could leave Ansoft/ANSYS immediately if I wanted to.

"IT IS LIKE DISCOVERING A NEW LANDSCAPE— THE WORLD IS NEW IN EVERY DIRECTION."

Kaizen: And yet you stayed on for another two years to effect a smooth transition? **Cendes:** I wanted to see the merger succeed. It would have hurt me very badly if everything I had built up over the years had been destroyed. I also felt close to my employees and wanted to do everything I could to ensure their continued success.

Navigating the waters between the former Ansoft culture and the new ANSYS culture was one of the most difficult things I have ever done. The ANSYS management initially didn't understand our products, markets, and procedures. It was a long process, but eventually ANSYS management learned the needs in the electromagnetic market and most people and procedures continued on as before. Although it was very difficult for me, I'm glad I stayed on because the old Ansoft organization has continued to grow and prosper within the ANSYS umbrella.

Kaizen: Now that the merger is behind you, what is next for Zol Cendes?

Cendes: I have been pursuing my dream of reinventing the finite element method. While the finite element method is now over 60 years old, certain aspects of the method are still mysterious. I have discovered a new approach to the finite element method that solves some of these mysteries. It is like discovering a new landscape—the world is new in every direction I look. I am exploring these new directions—sometimes I find something beautiful, sometimes I reach a dead end but it is always an exciting journey. I am in the process of writing a book describing the new theory.

Kaizen: Looking back on having been an entrepreneur for twenty-four years what has been the best thing to you about being an entrepreneur?

Cendes: It is fun. There is nothing more enjoyable than having a dream and a direction to go, waking up every morning and building a solution to a fundamental human need. Few people realize the need for electromagnetic field simulation. Nevertheless, every day you use products and technologies that would not exist without electromagnetic field simulation. Every entrepreneur faces the challenge and opportunity of improving the human condition in some way.

Kaizen: What has been the most challenging thing for you about being an entrepreneur?

Cendes: I've always focused on the opportunities rather than the challenges so it's hard to say. I suppose the times that we were running out of money to meet

the monthly payroll were the most stressful part of my career.

Kaizen: Entrepreneurs have to have initiative, guts, resourcefulness, perseverance, the ability to recover from setbacks, and so on. If you had to choose, which of those would you say is the most important?

Cendes: While all of these characteristics are important, more important than all of them is vision. An entrepreneur must have some idea of where he is going and what the purpose of the enterprise is. Once you have a vision, it still takes initiative, guts and all of the traits you mention—but without a vision, no amount of these traits will lead to success.

Kaizen: What advice would you give to potential entrepreneurs about how to cultivate those traits in themselves?

Cendes: Potential entrepreneurs need to think long term. What are the needs in the world and how do you satisfy them? You do this by looking at the world as it is and thinking about how it ought to be. Once you have a vision for the future, you need to focus on your goals rather than the difficulties. It is easy to have initiative, guts, perseverance, etc., if your mind is focused on your dream.

Kaizen: Many entrepreneurs have technical backgrounds, but they don't typically learn much about business in university. Is that a problem?

Cendes: No. Many successful entrepreneurs—Bill Gates and Steve Jobs come to mind—never took a business course in their lives. The most important aspects of business—having a vision, selling your product or service, raising money, managing a team of bright people—are not taught in business school. Entrepreneurs can hire people to do the technical aspects of business such as accounting and finance.

Kaizen: Is there anything your engineering education could have better prepared you for?

Cendes: That's an interesting question. Basically, no. While much of what I learned as an undergraduate is irrelevant today—in electronics I was taught about vacuum tubes—the fundamental thing in learned in engineering school was how to think. Technology changes so rapidly



Cendes at his home in Naples, Florida

that the specifics you learn are not important. What is important are the fundamental principles you learn that govern the world.

Kaizen: On the other hand, we live in a high-tech world of science and engineering, but not many people are scientifically literate. Is that problematic?

Cendes: Ignorance is never useful. It can even be destructive if a person lives and acts in a fantasy world removed from scientific reality. An interesting example is the current "singularity movement"—the notion that computers will overtake people in intelligence in a few decades and we will be able to live forever by downloading our brains into computers.

"FOCUS ON YOUR GOAL OF CHANGING THE WORLD AND NOT ON ANY MONEY THAT YOU MIGHT MAKE."

This notion is scientifically illiterate electronic computers are as different from biological brains as cars and trucks are from horses and oxen.

Computers are built with a central processing unit (CPU), random access memory (RAM) and data buses. They process data linearly with access only though a data bus, they never lose a bit of data or make a mistake, and operations such as two plus two equals four are hardwired. In contrast, neurons in brains have thousands of connections, people often forget things and make mistakes, and people need to think to perform math and other operations. On a fundamental level, people have free will and think in terms of concepts; computers are deterministic and don't think at all. At this point, we don't even know how the atoms in our brains form concepts, let alone how to make a computer think.

Kaizen: What is the best advice you've been given from a mentor?

Cendes: The mentor in life was my PhD advisor Professor Peter Silvester. He was the only genius I ever knew. He taught me that reality is knowable through thought and that we can achieve goals by focusing on the fundamentals.

Kaizen: In closing, what advice would you give to young people just starting out in their careers?

Cendes: Follow your dream. Life has amazing possibilities—don't waste them. My advice is to focus on your goal of changing the world and not on any money that you might make. If you are successful, you will be rewarded for your efforts. It is mistake to pursue wealth without achievement.

Remember that the world rewards value with value, so you must produce something valuable before you can become rich.

This interview was conducted for Kaizen by Stephen Hicks. Our full interview with Zol Cendes will be posted at http://www.ethicsandentrepreneurship.org.

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