University of Minnesota

SIGNALS

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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ECE Alumni Taking Entrepreneurial Leap

In addition to sharing an alma mater, ECE alumni Thomas Rusch and Branislav Vajdic share a passion for innovation and a bold entrepreneurial spirit.

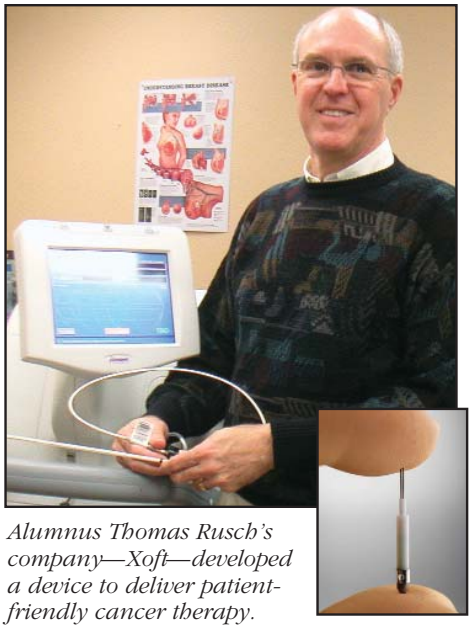
In some ways, Thomas Rusch (B.S.1968, M.S. 1970, Ph.D. 1973, and 1993 M.S. Management of Technology) and Branislav Vajdic (M.S. 1981, Ph.D. 1984) couldn't be more different from one another. Rusch, who grew up in Richfield, Minnesota, was pretty much the hometown boy who chose the in-state university because it was a very good engineering school that was affordable. Vajdic, a native of Yugoslavia, came to the U.S. in search of a high quality graduate education and was drawn to the academic reputation and the friendly atmosphere he discovered at the University of Minnesota's Electrical and Computer Engineering department.

Today, however, both alums are the proud founders of promising new California-based companies in the medical technology industry.

Tiny X-ray Source Offers Therapy Alternatives

Rusch got the idea for his new business—Xoft, Inc. (pronounced "zoft")—while working as a consultant for a former St. Paul company that was looking to develop a very small X-ray source that could be used to treat narrowing vessels in the heart. The company hit development roadblocks and funding problems. After their non-compete agreements expired, Rusch and two colleagues (Paul Lovoi and Michael Forman) founded Xoft with the idea of using the extremely small X-ray source for treatment of various forms of cancer, in addition to cardiovascular disease.

"There are two primary forms of radiation therapy used to treat cancer," said Rusch. "The first—teletherapy—uses an external radiation source to pass a beam through the body to reach the tumor. The second—brachytherapy—is done from inside the body. Typically, radioactive materials are used in brachytherapy."



Alumnus Thomas Rusch's company—Xoft—developed a device to deliver patient-friendly cancer therapy.

Therein lay the opportunity for Xoft. By using a very small X-ray source—two millimeters in diameter—Rusch and his colleagues believed they could provide a safer way to treat cancer. The x-ray source is threaded inside the body using methods similar to those used with other catheters. Then radiation can be applied directly to the tumor without passing through surrounding healthy tissue.

Heart attack victims may soon have access to ECG technology that is 24 percent more accurate than current technology, thanks to alumnus Branislav Vajdic.

"We zeroed in on breast cancer as our first oncology application," said Rusch. "We wanted to be able to help a large number of people—plus, breast cancer detection has become much better in recent years and the treatment success rate is very high when the cancer is detected early on."

Today, Xoft's x-ray technology is being used to treat breast cancer patients in a controlled study at 10 clinical sites around the U.S. The response has been very positive.

Rusch's fledgling company, which is moving into new quarters in Sunnyvale, California, is building its sales staff, developing awareness of their new product, and scurrying to provide ample customer and patient support. The future looks bright, according to Rusch, thanks to the minimally invasive nature of their product.

"Because the radiation doesn't penetrate very deeply into surrounding healthy tissue, we think our device has great potential for treating a number of other cancers, including endometrial or gastrointestinal cancers," he said.

ECG Breakthrough Boasts Better Success Ratio

Success in treating heart attack victims is hugely dependent on an early and accurate diagnosis. Unfortunately, the primary screening tool in use today—the electrocardiogram or ECG—is only accurate about 60 percent of the time. Thanks to a breakthrough development by New Cardio, a company founded by Vajdic, doctors now have access to a tool that is 84 percent accurate.

"Our new tool—called simply Visual ECG—is a computer modeling engine that uses the standard data collected for a 12-lead electrocardiogram," said

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Computer Aided Design Group Growing in Prominence

A thriving faculty, a growing body of accomplished graduate students, and a dynamic research program that attracts more funding every year are the earmarks of a first class program in computer aided design.

As the senior member of the Electrical and Computer Engineering Department's Computer-Aided Design (CAD) group, Professor Sachin Sapatnekar is the de facto spokesperson for CAD research in the department. Sapatnekar came to the University in 1997 and in the 10 years since, he has seen the program blossom.

"There aren't any concrete national rankings to turn to when it comes to CAD programs," said Sapatnekar. "But there are some reliable measures that demonstrate how far we've come in the past few years."

Among those measures are the positions of prominence awarded to faculty members within CAD professional organizations. On that front, Sapatnekar has just finished serving as technical chair for the Design Automation Conference for the past two years. And Associate Professor Jaijeet Roychowdhury has been selected to serve as Technical Program Chair for the 2008 *IEEE International Conference on Computer-Aided Design*. Always of interest, too, is the amount of research funding the program brings in annually. Recently, CAD research has secured in excess of $1 million in research funding annually, according to Sapatnekar. But he is quick to point out, there is perhaps even a better informal measure of the success of the ECE CAD group: the overall quality of its faculty.

Thriving Faculty

The CAD researchers in ECE consists of a core group of five professors: Sapatnekar, Roychowdhury, Associate Professor Kiarash Bazargan, and Assistant Professors Marc Riedel and Chris Kim. Other ECE faculty members who do substantial amounts of CAD research include Professors David Lilja, Ramesh Harjani, and Keshab Parhi. Sapatnekar told an anecdote that readily illustrates how strong the department's reputation has grown.

"When Marc Riedel applied for a job here, he had also applied for jobs at 10 other institutions," said Sapatnekar. "And he received offers from all 10—but he took the job here."

Of course, a strong faculty attracts strong graduate students and both the number and quality of those students has been growing, too.

"We currently have about 25 Ph.D. students—which is pretty impressive for a group our size," said Sapatnekar. "As those students grow into positions of prominence, it will improve the reputation of our department, too."

Spotlight on Research

The demand for CAD research is booming, according to Sapatnekar, and is likely to continue well into the future. And the need is strong, at both ends of the spectrum.

"As systems become larger, there is a much greater need to be able to abstract them into mathematical problems that can speed up their analysis and characterization," said Sapatnekar. "And, at the other end of the scale, as transistors become smaller and smaller, new physical effects come into play—and this, too, calls for CAD solutions."

Roychowdhury is currently working on a couple of CAD research projects that illustrate the need for efficient mathematical representations of enormously complex systems. In a project for Intel, Roychowdhury and his research group are developing an approximate and simple way to characterize the likely performance of "latches" (sequential elements in microprocessors that have memory) in the next generation of microprocessors.

"Finding the set-up and hold time of all the different kinds of latches is an enormously complex computational problem," said Roychowdhury. "It was taking Intel—with all of its computing power—about three months of continuous computer run-time to perform the necessary calculations."

No more. Roychowdhury and his research group were able to speed the process up anywhere from two to three times in some situations—and as much as 20 times in others.

"We borrowed some techniques from RF simulation and adapted them to the problem at hand," he said.

In another research project, Roychowdhury is working with Medtronic to try to help them develop CAD techniques that will allow them to better characterize fibrillation in the heart. Fibrillation is a rapid, uncoordinated series of contractions of the heart muscle causing weak, and irregular heartbeat. It is the result of the oscillation of billions of cells of heart muscle.

Using numerical techniques that compress 16 equations into one, Roychowdhury has been able to develop simulation models that speed up the analysis of fibrillation by two orders of magnitude. Their work may one day enable Medtronic to develop tools for full-heart simulation.

"This is very exciting work," said Roychowdhury. "It may one day reduce the need for animal experimentation and vastly improve the way we understand the human heart."

Roychowdhury's research exemplifies the kind of work going on elsewhere in the group, too, according to Sapatnekar.

"Having such a strong group in CAD research will also open the doors to a number of collaborative efforts in the years ahead," he said. "Along with a strong reputation, we have a very supportive environment for success within the department. This is a fun group to work with."

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Vajdic. "It uses that data to generate a three-dimensional representation of the heart's electrical activity that is easy to read and much more reliable in determining whether or not the patient is undergoing a heart attack."

The 84 percent performance of New Cardio's Visual ECG was documented in a study at Harvard University. But Vajdic believes he and his colleagues will eventually drive their success rate up to 90+ percent.

"The beauty of this system is that the hospitals don't have to go get new machinery and they don't have to change their procedures," said Vajdic. "Our product builds a sophisticated model of the heart's electrical activity that provides exact information in an easy-to-read format."

As a follow-up to the Harvard study, Visual ECG is being placed in emergency rooms and will be used with a thousand patients during the next year or so. New Cardio has two other products in the market place: QTinno and Cardio Bip. QTinno is another modeling program that is expected to help drug manufacturers speed up the development of new drugs by providing a better technique for measuring the so-called Q-T interval in an ECG. Cardio Bip is a handheld device that can be self-administered to provide a standard 12-lead ECG. Other such portable devices require trained medical personnel and the application of multiple leads. CardioBip can simply be pressed to the patient's chest and, from one point of contact, develop a complete set of ECG data.

"This is a very exciting time for our company," says Vajdic, who serves as New Cardio's CEO. "We formed our company in September 2004 and just recently completed the transition to a publicly traded company. By this time next year, we expect to have real revenue."

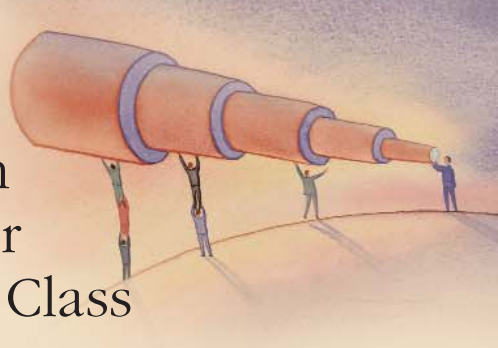
For more information about Rusch and Xoft, Inc., visit their website at: http://www.xoftinc.com/
For more information about Vajdic and NewCardio, Inc., visit their website at: http://newcardio.com/

IN THE CLASSROOM

■ ECE graduate student **Juan-Andres Bazerque** won the CrownCom 2007 Best Student Paper award for his paper "Distributed Scheduling and Resource Allocation for Cognitive OFDMA Radios." Bazerque's advisor, ECE Professor **Georgios B. Giannakis**, was co-author.

■ ECE student **Chenjie Gu** and **Professor Jaijeet Roychowdhury** co-authored a paper "An Efficient, Fully Nonlinear, Variability-Aware non-Monte-Carlo Yield Estimation Procedure with Applications to SRAM cells and Ring Oscillators," that received the Best Paper award at the 13th Asia and South Pacific Design Automation Conference.

■ A paper titled "On using the streamwise traveling waves for variance suppression in channel flows," by ECE graduate student **Rashad Moarref** and Professor **Mihailo Jovanovic**, was selected as one of the top five student papers presented at the 2007 American Control Conference (ACC). The ACC is one of the major conferences in the area of control engineering.



Profs Team Up to Offer New-Look Class

Last year, 37 senior ECE students got a rare opportunity to take team-taught course that allowed them to step away from the usual theory-heavy requirements of their undergraduate course work and take a deep, if brief, dive into the real world of electrical engineering. The course, a special topics course on radio frequency (RF), optical, and magnetic systems, was team taught by Professors Rhonda Franklin Drayton, Jim Leger, and Randall Victora.

"The basic idea was to expose our students to real world problems in these fields," said Drayton, who came up with the idea for team teaching the project-based course. "By getting them involved in the design experience as undergraduates, we gave them a better sense of how theory gets applied in the physical world—which is what engineering is really all about."

"The undergraduate electrical engineering curriculum doesn't offer a large number of fields and photonics electives," added Leger. "We have given these undergraduates an introduction to topics more typically reserved for graduate students in the hopes that some of the students may pursue these topics further in graduate school."

The course was built around the common theme of information technology. It was divided into three five-week segments, each of which zeroed in on how one of the topics (RF, Optics, and Magnetics) might be related to the basic workings of a personal computer.

"A PC has wireless cards, optical drives, and magnetic hard drives so this scenario provided fruitful ground," said Leger. "Rhonda, Randy, and I initially worked together as a team to introduce the common themes that link our three areas. The remaining class time was spent providing foundational material and working on student projects that emphasized one of these three technical areas."

The five-week length of the segments was challenging for both students and faculty, but the outcomes were nonetheless impressive.

"The short timeline and project approach was really helpful," said Drayton. "It forced team members to collaborate. No one had the advantage, and everyone had to contribute —so the students learned a great deal from one another."

"The course balanced depth and exposure to multiple topics in a very valuable way," added Victora. "It helped students see how various less-traditional electrical engineering careers fit into the picture. Several of the students found employment at a local magnetic recording company and commented to me about the usefulness of this course in view of their new jobs."

Although participating in this class created an additional teaching load for each of the faculty members, they all agreed it would be fun to do the course again.

"Technology changes so quickly, it's difficult to keep up," explained Drayton. "Courses like this enable us to be creative and connect the past with the present without covering the entire evolution of a particular technology—which give students enough background to be successful."

SIGNALS

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IN BRIEF

■ Professor **Doug Ernie** has been named an associate dean of the Institute of Technology Graduate School. Ernie's responsibilities include expanding the Graduate School's capacity to conduct academic program reviews and administering a newly established review process for interdisciplinary centers, institutes, and initiatives throughout the University.

■ Professor **Tryphon Georgiou** presented an invited plenary talk at the 46th IEEE Conference on Decision and Control (CDC), which was held in New Orleans on December 12-14, 2007. This is the premier conference in the controls field.

■ Assistant Professor **Chris Kim** received an IBM Faculty Partnership Award for a second year to support his work on "Power and Performance Management Techniques for Aging Tolerance." The objective of this project is to investigate adaptive techniques to mitigate the impact of device gain on circuit performance. The IBM Faculty Awards program is a competitive worldwide program that enhances collaboration between faculty at leading universities and IBM researchers.

■ Professor and Department Head **David Lilja** received the Professional Achievement Citation in Engineering (PACE) from the Iowa State University College of Engineering. The PACE award honors Iowa State engineering alumni for their superior technical or professional accomplishments in research, development, administration, education and other engineering activities.

■ Professor **Dennis Polla** received the Defense Advanced Research Projects Agency Award for "Outstanding Portfolio of Programs." Polla was cited for "considerable initiative and technical and program management skills in the development of micro/nanosystems technology.

■ A paper titled "Interdependent Latch Setup/Hold Time Characterization via Euler-Newton Curve Tracing on State-Transition Equations," by ECE graduate student Shweta Srivastava and Associate Professor **Jaijeet Roychowdhury**, was given a Best Paper award from the 44th annual Design Automation Conference in June 2007.

■ A paper titled "New Possibilities with Sobolev Active Contours," co-authored by Ganesh Sundaramoorthi, Anthony Yezzi, Andrea C. Mennucci, and Professor **Guillermo Sapiro**, received the Best Numerical Paper-Project Award at the International Conference on Scale Space and Variational Methods in Computer Vision in Ischia, Italy. Anthony Yezzi, who is currently on the ECE faculty at the Georgia Institute of Technology, received his Ph.D. in electrical engineering from the University of Minnesota.

■ Associate Professor **Jerry Sobelman** has been selected to serve as an IEEE Distinguished Lecturer for 2008-09 by the IEEE Circuits and Systems Society.