Winter 2007

WIMS WORLD

University of Michigan Michigan State University Michigan Technological University

Director's Message

I guess I've given hundreds of talks in my career, but two recent ones certainly rank among the most important, or at least the most memorable. The first of these was a plenary talk at the International Electron Devices Meeting last December. They wanted me to focus on implantable biomedical microsystems so I spent several weeks collecting slides from helpful colleagues and weaving them into a presentation that I thought would fit the IEDM audience. Then three days before the talk, the cold I had been fighting found a home in my throat and I lost my voice! When I went to see my doctor, he smiled at my predicament and prescribed some pills that gave me hope, if not complete relief. Hedging my bets, I then wrote out the entire talk, warning a colleague that he might have to step in and deliver it while I stood smiling at his side. Fortunately, that didn't happen. I somehow managed to croak my way through it, and although less than my finest hour, it was certainly a memorable experience.

Ken Wise giving the Henry Russel Lecture.

The second talk was this March, given in connection with the 2007 Henry Russel Lectureship that I was receiving. Presented in the University of Michigan's Rackham Amphitheatre, this was an opportunity to address the executive officers of my university and educate them about WIMS. It was a particularly important talk, given current efforts to define the future of our Center after NSF support ends in 2010. The only negative was a nagging suspicion that I was there either because there had been a dreadful mistake (which they would soon discover) or because it had been a really slow year for nominations! The first was perhaps unlikely, but the second seemed plausible; nonetheless, it was a chance to tell our leadership about WIMS. There was no laryngitis this time, and I tried to put myself at ease by reminding myself that this was not the most prestigious audience I had ever addressed. (That one was a Physics Colloquia at Stanford in 1970, where four Nobel Laureates were seated in the front row, including Felix Bloch and William Shockley.) The Russel turned out to be a wonderful event and very much appreciated.

A few days later, I was sifting through e-mail when I noticed one from a former student whom I hadn't heard from for several years. She was my first female doctoral student, and as I looked at her message, I remembered our trip to San Francisco nearly 20 years earlier and the presentation she gave there at IEDM. After graduating, she joined IBM, and while we corresponded occasionally, I really hadn't kept up with her work. It turned out that she was one of the former students who wrote letters recommending me for the Russel Lectureship. She attached a copy of her letter, and reading it, I finally understood why I was chosen. If nothing else, some of my former students write very well! I replied that if half what she put in the letter were really true, I would count my career a real success. She then assured me that she meant at least half of what she wrote—maybe even two-thirds! The next few evenings were spent trading messages and getting caught up with her activities and thoughts on engineering as a career. I have now guided fourteen female doctoral students; twelve of them are practicing engineers today, while two are taking time off to raise families or engage in other pursuits. In this regard, compared to men, women face more complex choices, but in many ways have a greater range of possibilities.

The nicest thing about the Russel Lectureship is that it is, in part, based on recommendations from former students. For any teacher, the supreme compliment is to have a former student, especially years later, stop to say thanks. I had a number of teachers who served as great role models, one of whom was a high school English teacher. The other day, I googled his name and was surprised to find him listed on the Web, even though he passed away almost 25 years ago. I remember calling him in the late 70s after coming to Michigan. We then exchanged several letters. The article noted that he began teaching in a one-room country school in 1919, and that he could read, write, and speak French, German, Latin, and Old English. He was also an expert on the Pennsylvania Dutch. He retired in 1960, after teaching in our high school for 33 years, which is how long I've now been at Michigan. The article also noted, "It is a measure of the esteem in which he was held that when he passed away he was still being thanked by students he had helped, even though he had retired 22 years earlier." I hope that my saying thanks meant as much to him as hearing from my former students means to me. He made a real difference.

It's been great being able to combine engineering and teaching, and it's great working in an area as exciting as WIMS, which will change the world for the better in ways we don't yet dream.

Ken D. Wise

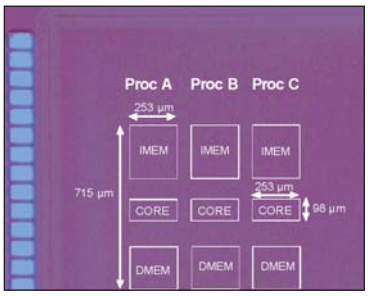
Director, Engineering Research Center for Wireless Integrated MicroSystems

Research Highlights

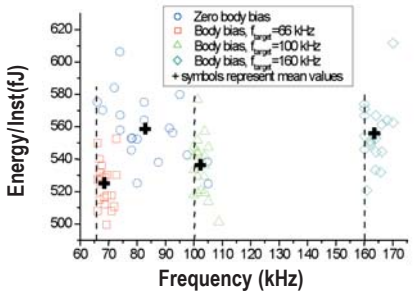
Subliminal Processor: An Ultra-Low-Energy Microcontroller for Sensor Network Processing

Dennis M. Sylvester and Scott M. Hanson

Energy-efficient data processing remains one of the primary targets of WIMS research. Any mobile system, from medical implants to environmental sensors, requires robust digital components with a maximum battery lifetime. With the Subliminal Processor, we have recently made important advances in understanding the limits of energy-efficient digital computing. The Subliminal Processor is a simple 8-bit microcontroller that uses aggressive voltage scaling into the subthreshold regime (i.e., the supply voltage is less than the transistor threshold voltage) to achieve 10–20X energy reductions when compared to operation at nominal voltages. Operation at such low voltages is complicated by high sensitivity to process variations, as well as increased computation times. We have made significant progress in understanding and addressing these problems with two generations of the Subliminal Processor. The first generation was the most energy-efficient processor ever reported, with the CPU (no memories) consuming only 850 fJ/instruction. Recent testing of the second-generation Subliminal Processor, which is operational at supply voltages as low as 150mV, shows that it is even more energy efficient than the first version, with the CPU consuming only 515 fJ/instruction. The second-generation Subliminal Processor was also used to explore techniques for reducing sensitivity to process variations. In particular, we found that tuning of the device body biases can virtually eliminate performance variability in subthreshold circuits and help minimize energy variability. Experimentation with different performance-enhancement techniques also shows that body biasing can be used to achieve circuit-level performance improvements with a negligible energy penalty. For gate-level performance improvements, we find that the use of increased gate lengths (as opposed to the traditional approach of using increased gate widths) is most effective due to reverse short-channel effects. While subthreshold operation has not yet been adopted within commercial applications, our work suggests that careful design will make it a viable and attractive option in the near future. ■



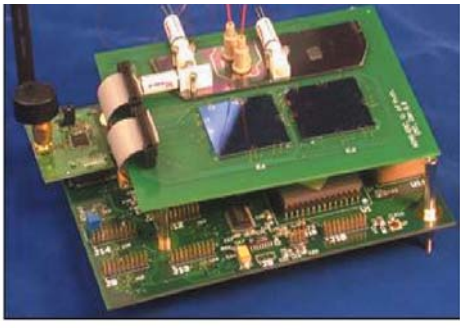
Die photo of three variants of the second-generation Subliminal Processor.

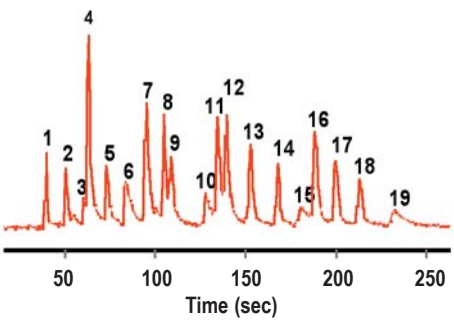


Different body bias configurations minimize energy and performance variability in 20 dies measured at Vdd=300mV.

Complex Mixture Analysis With a Wireless Microsystem

Edward T. Zellers



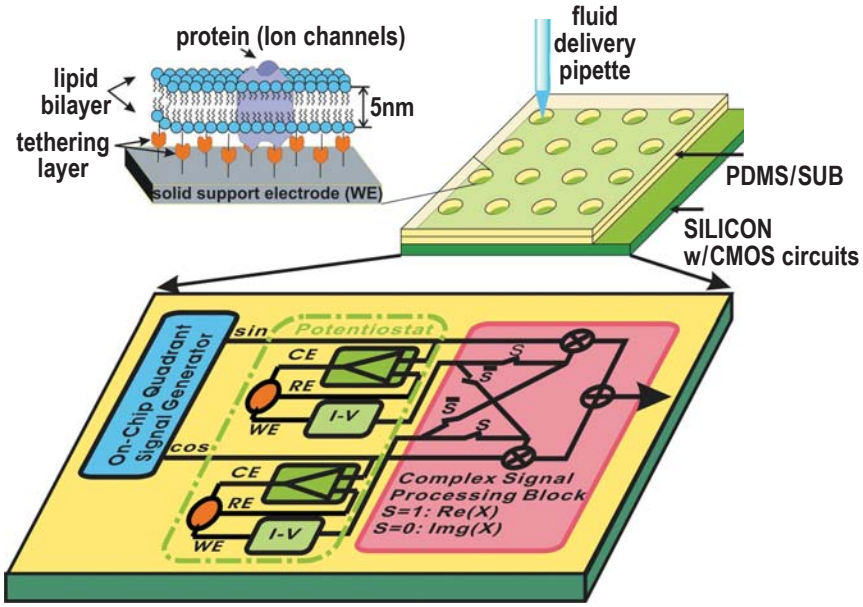


Determining the composition of complex mixtures of gases and vapors *in situ* is critically important to effective security screening, human and ecological exposure assessment, industrial emission monitoring, and biomedical surveillance and diagnosis. The WIMS micro-GC (μGC) is a low-power integrated microsystem designed to meet the needs of all such applications. Representing the culmination of several years of work, the μGC combines the following components, all made using MEMS technologies: a sample inlet with particulate filter, passive calibration vapor source, multi-stage preconcentrator/focuser (μPCF), dual-column separation module with pressure- and temperature-programmed separation tuning, an array of microsensors for analyte recognition and quantification, and system pressure and temperature sensors. Flow is provided by a miniature off-substrate pump. This year, we have succeeded in integrating fluidic, electronic, and RF-wireless subsystems in a hybrid prototype and performing rapid, high-quality analyses of multi-vapor mixtures. The prototype system (upper left) was used to analyze a mixture of 19 indoor air contaminants of anthropogenic and microbial origin in just under 4 minutes (see single-detector chromatogram at lower left). Drawing on the collective expertise of students and faculty from numerous disciplines across several departments and universities, this effort epitomizes the type of multi-disciplinary research made possible by ERC funding. This integrated microsystem has garnered active interest from numerous governmental and private-sector organizations seeking to license the technology or engage in collaborative, application-specific development projects, or both. ■

On-Chip Electrochemical Impedance Spectroscopy for Membrane Protein Biosensors Array Microsystems

Andrew J. Mason

Membrane proteins are excellent biological recognition elements that can be embedded with synthetic tethered bilayer lipid membranes (tBLM) to form nanostructured biomimetic interfaces. In this research, we are developing electrochemical impedance spectroscopy (EIS) circuitry that will enable monolithic implementation of biomimetic sensor array microsystems, providing significant improvements in measurement resolution and throughput and manufacturing cost. For many membrane proteins, EIS provides tag-free, reversible analysis that permits fully electronic biosensor systems. However, entirely on-chip EIS systems have yet to be developed. Moreover, impedance analysis of tBLMs requires sub-Hertz excitation frequencies that must be accommodated by readout circuitry. Typically, EIS is performed by integrating circuits that suffer from very long measurement times for sub-Hertz signals compromising the throughput of array readings. Thus, we have introduced a new EIS algorithm and circuit that performs complex-domain (real and imaginary components) signal processing using analog electronics. The new approach requires only 20msec to read out each sensor element, independent of excitation frequency, significantly improving readout speed for tBLM-based biosensors. The new circuit enables the next generation of high-throughput biosensor array microsystems based on membrane proteins for biomedical studies, drug screening, or environmental and homeland security monitoring. ■



Protein-embedded tBLM sensor arrays are built on top of the silicon surface; the electrical system underneath generates quadrature signals for two identical sensor elements, and the responses are processed in complex signal domain to get the real and imaginary portions of impedance information.

Recent Events

Planning for the Future

The WIMS ERC, funded by the National Science Foundation and now in its seventh year, continues to merge very low-power embedded computing and wireless technology with integrated sensors to realize devices capable of measuring a variety of physical parameters, interpreting them, and communicating wirelessly with larger distributed systems. During the next two decades, such microsystems are expected to become pervasive, sparking revolutionary progress in health care, environmental monitoring, homeland security, and other areas. The Center's **Scientific Advisory Board** met on March 20, in the University of Michigan's Lurie Engineering Building, to help plan for the future. Calling the WIMS ERC a tremendous success and a world leader, the Board is helping develop a bold vision that builds on existing strengths to take the Center to a whole new level, drawing on university-wide expertise and national and international alliances to tackle the critical problems of the 21st century. ■

The Center's Scientific Advisory Board at their meeting on March 20, 2007. From Left: Center Director Kensall D. Wise, Lawrence D. Burns (GM), Gilbert V. Herrera (Sandia), Chih-Ming Ho (UCLA), Robert M. Nerem (GaTech), Sandip Tiwari (Cornell), and Center Deputy Director Khalil Najafi. Kurt E. Petersen (SiTime) attended by phone; James F. Patrick (Cochlear) could not attend due to previous commitments in Australia.

Education Highlights

Detroit-Area Students Bring Youthful Excitement to WIMS

Twenty-one Detroit-Area Pre-College Engineering Program (DAPCEP) seventh- and eighth-grade students enjoyed their introduction to WIMS and electrical engineering and computer science (EECS) during five Saturday sessions in March 2007. During the sessions, application-focused presentations followed by hands-on experiments composed the format, supported by careful, enthusiastic mentoring by the Center's Student Leadership Council and graduate students in several other programs (computer science and engineering, biomedical engineering, and mechanical engineering).

Specific topics comprised sensors, actuators, microsystems, wireless infrared communication, programming concepts, digital logic functions and electronic components, addition via digital binary methods, and energy systems (sources, collection, storage, distribution, and efficient usage). On the fourth Saturday, March 24, the students visited COSI (Center of Science and Industry) in Toledo, Ohio. On the fifth Saturday, March 31, a closing ceremony was held, with the students receiving certificates and program t-shirts. To help assess the program's academic efficacy, a pre-test was given on the first Saturday, and a post-test on the last Saturday.

A typical Saturday schedule involved pickup by bus at 8 a.m. from a church in Detroit, bus ride to the Center's facilities in the University of Michigan's Engineering Programs Building (EPB), a morning session from 9 a.m. to 11:15 a.m., a 30-minute lunch, an afternoon session from 11:45 a.m. to 1:15 p.m., and a return bus ride to the church with arrival at 2:30 p.m.

Funding for the program is provided by the University of Michigan's EECS Department and the Center, along with much administrative support by several WIMS ERC staff. ■

DAPCEP students work on their robots.

Graduate student mentor, Amar Basu, assists one student team in building their robot.

Personnel Focus

Katsuo Kurabayashi is Associate Professor of Mechanical Engineering and Electrical Engineering and Computer Science at the University of Michigan. He received his B.S. degree (1992) from the University of Tokyo and his M.S. (1994) and Ph.D. (1998) degrees from Stanford University. Dr. Kurabayashi's research areas include mass/thermal energy transport, tunable optical dispersion, and programmable protein/cell patterning in MEMS/NEMS and microfluidic systems for high-fidelity RF MEMS switching, on-chip fluorescence spectroscopy, biosensing, and tissue engineering research.

Within the WIMS ERC, Dr. Kurabayashi's team is developing a microfabricated thermal modulator, which is a key subcomponent of the WIMS μGC to achieve high sensitivity by providing 10- to 50-fold detection enhancement. His team aims to design, fabricate, and test a MEMS-based thermal modulator that can be integrated with microfabricated GC columns to generate heating and cooling cycles between -40°C and 300°C over short timescales (<100ms). The project is also supported by the NASA Astrobiology Program that has a primary mission to explore organic signatures on extraterrestrial bodies within the solar system. The μGC system, incorporating the MEMS thermal modulator, allows NASA to meet significant challenges in its mission, including separation of resident organics from spacecraftborne organic contamination and differentiation of biotic and abiotic syntheses with limited power resources.

In collaboration with Edgar Meyhofer and Shuichi Takayama, both colleagues at the University of Michigan, Dr. Kurabayashi's team is also currently working to develop non-voltaic biomolecular motor-based bio-concentrators and electro-wetting-on-dielectric (EWOD) microfluidic devices under the support of NSF and NIH. These devices will open the door for battery-free, point-of-care medical diagnosis and fundamental research in cell biology.

Dr. Kurabayashi is a recipient of the Semiconductor Research Corporation (SRC) Best Paper Award (1998), the NSF CAREER Award (2001), and the University of Michigan Robert Caddell Memorial Award (2004). He spent the summer of 2006 as a Visiting Professor at Tokyo Institute of Technology under a grant from Japan's Ministry of Education, Culture, Sports, Science and Technology. ■

Faculty/Student Awards

Michael Flynn Receives 2007 Guggenheim Fellowship

Michael Flynn, Associate Professor in the Solid-State Electronics Laboratory at the University of Michigan, and also the WIMS ERC Wireless Thrust Leader, received a highly prestigious 2007 Guggenheim Fellowship for his research into the fundamental limits of analog-to-digital conversion. Guggenheim Fellowships are given annually for distinguished achievement in the past and exceptional promise for future accomplishments.

Wan-Thai Hsu (Discera) Receives Innovator of the Year EE Times ACE Award

Discera's chief technology officer, Wan-Thai Hsu, was honored with the EE Times Annual Creativity in Electronics (ACE) Award for Innovator of the Year. Honors were presented at the EE Times ACE Awards Gala, as part of the Embedded Systems Conference Silicon Valley. Discera is a world leader in CMOS MEMS oscillators, resonators, and next-generation timing solutions.

Michel Maharbiz Receives Keck Foundation Grant

Michel Maharbiz, Assistant Professor in the Electrical Engineering and Computer Science Department at the University of Michigan, is the principal investigator of an interdisciplinary and multi-institutional team that won a prestigious W. M. Keck Foundation grant. The W. M. Keck Foundation supports pioneering discoveries in science, engineering, and medical research that lay the groundwork for breakthroughs and new technologies that provide far-reaching benefits for humanity.

Ken Wise Gives Henry Russel Lecture

Professor Kensall Wise, WIMS ERC Director, presented the talk, "WIMS: Sparking Breakthroughs in Health Care and the Global Environment," on March 13, 2007, at the University of Michigan's Rackham Amphitheatre. He discussed the research advances made possible through the WIMS ERC, which will improve healthcare, the environment, and homeland security. The Henry Russel Lectureship is one of the highest honors bestowed on a faculty member by the University of Michigan.

University of Michigan Undergraduate Students Receive Awards

Joseph Steinmeyer, undergraduate student in electrical engineering and computer science, was presented with the Henry Ford II Distinguished Class Prize, which is given to an outstanding junior who has demonstrated academic excellence. He also received the Undergraduate Outstanding Research Award. This award is given to students who do exceptional work above and beyond the requirements in a course or an independent project with a faculty member or graduate student.

Adam Barnett, undergraduate student in electrical engineering and computer science, was presented with the Undergraduate Outstanding Research Award (Honorable Mention).

Kwan Chong Tan, undergraduate student in electrical engineering and computer science, received the Senior Outstanding Achievement Award and also the Mildred and Steele Bailey Prize, which is presented to an outstanding senior who has demonstrated academic excellence, leadership qualities, and notable contributions to the University or community, or both. ■

Special Feature

Spelman College Professor Collaborates With WIMS ERC

Jean-Marie (John) Dimandja is an Associate Professor of Chemistry at Spelman College in Atlanta, Georgia. He received his B.A. in mathematics from Miami University (Oxford, Ohio) in 1989, and his M.S. and Ph.D. degrees in analytical chemistry from Southern Illinois University in 1992 and 1997, respectively. He then worked as a research scientist at the Centers for Disease Control from 1997 to 2002, where he developed several novel biomonitoring methods for environmental toxicant screening. Since joining Spelman College in 2002, his research has focused on instrument and method/applications development using the emerging technology of comprehensive two-dimensional gas chromatography (GCxGC), which was invented and patented in the laboratory where he conducted his graduate work at Southern Illinois University. The instrument development projects include (1) the design of an optimization mixture that is capable of monitoring the effect of any change that is made to the GCxGC system and (2) the development of advanced data processing software for use in non-commercial systems such as those under development in the WIMS ERC. Method development projects span a wide variety of interests, embracing environmental, biomedical, and industrial applications.

John's research projects have been supported by several federal grants (NSF and NIH) and corporate sponsors, which have helped support over 20 undergraduate students in the past 5 years. A number of his former students are pursuing post-baccalaureate degrees at top institutions such as Tufts University, Vanderbilt University, and the University of Michigan. He has authored over 20 peer-reviewed publications and has given over 120 presentations at local, national, and international conferences. He has also organized or chaired over 10 conference symposia on GCxGC under the auspices of the Pittsburgh Conference (PITTCON), the American Chemical Society (ACS), the International Symposium on Capillary Chromatography and Electrophoresis (ISCCE), and the International Symposium on Multi-dimensional Gas Chromatography. ■

Presentations and Publications

Conference Presentations

IEEE International Conference on Micro Electro Mechanical Systems (MEMS), Kobe, Japan, January 2007

A. Basu and Y. B. Gianchandani, "Virtual Components for Droplet Control Using Marangoni Flows: Size-Selective Filters, Traps, Channels, and Pumps," pp. 401–404

C. K. Eun, T. Fung, B. Mitra, and Y. B. Gianchandani, "Mechanically Enhanced 3-Electrode Wireless Micro-Geiger Counter," pp. 599–602

T. V. Galchev, W. C. Welch III, and K. Najafi, "Low-Temperature MEMS Process Using Plasma Activated Silicon-On-Silicon (SOS) Bonding," pp. 309–312

S. Wright and Y. B. Gianchandani, "A Harsh Environment, Multiplasma Microsystem With Pressure Sensor, Gas Purifier, and Chemical Detector," pp. 115–118

H. Kim, A. Astle, K. Najafi, L. P. Bernal, and P. Washabaugh, "A Fully Integrated High-Efficiency Peristaltic 18-Stage Gas Micropump With Active Microvalves," pp. 131–134

H. Kim, A. Jauregui, C. Morrison, K. Najafi, L. P. Bernal, and P. Washabaugh, "Low-Power Electrostatic Microthruster for Propulsion Based on Helmholtz-Resonance," pp. 127–130

S. Lee, J. Y. Cho, and K. Najafi, "Fabrication of Vertical Comb Electrodes Using Selective Anodic Bonding," pp. 349–352

J. S. Mitchell and K. Najafi, "Localized Back-Side Heating for Low-Temperature Wafer-Level Bonding," pp. 377–390

J. M. Park, T. R. Brosten, A. T. Evans, K. Rasmussen, G. F. Nellis, S. A. Klein, J. R. Feller, L. Salerno, and Y. B. Gianchandani, "A Piezoelectric Microvalve With Integrated Sensors for Cryogenic Applications," pp. 647–650

M. T. Richardson, S. R. Green, and Y. B. Gianchandani, "Magnetoelastic Wireless Sensing of Tissue Growth for Self-Expanding Biliary Stents," pp. 469–472

W. Zhu, M. J. White, D. W. Hoch, G. F. Nellis, S. A. Klein, and Y. B. Gianchandani, "Two Approaches to Micromachining Si Heat Exchanger for Joule-Thompson Cryosurgical Probes," pp. 317–320

International Conference on Integration and Commercialization of Micro and Nanosystems, Sanya, Hainan, China, January 2007

P. Obiomon, A. Holland, J. Holland, and E. Smith, "An Integrated Microsystem for Environmental Sensing Powered by Energy Scavenging"

Pittcon '07, Chicago, Illinois, February 2007

E. T. Zellers, W. H. Steinecker, M. P. Rowe, G. R. Lambertus, S. M. Reidy, J. A. Potkay, H. Kim, C. Avery, H. K. Chan, R. D. Sacks, K. Najafi, L. P. Bernal, and K. D. Wise, "A MEMS Gas Chromatograph for Determination of Toxic Industrial Chemical Mixtures"

Industrial Liaison's Report

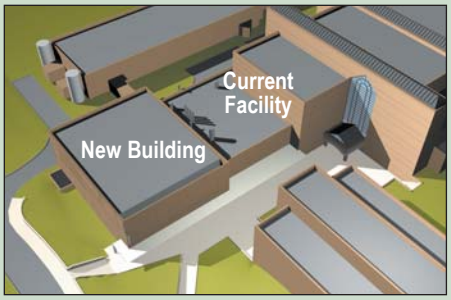
Industrial Advisory Board Meeting October 23–24, 2007

While compiling data for our annual report to the National Science Foundation, I noted that as we were reporting on the progress made in the last year, the Center may not be fully representing its total impact on the community. In particular, the Center is heavily involved in training students to take an entrepreneurial look at the technology we are developing. In conjunction with the Zell Lurie Institute for Entrepreneurial Studies, the University of Michigan's College of Engineering is offering courses to engineering students that train them to assess the commercial viability of the technologies.

A number of WIMS ERC students have taken the courses and have been involved in business competitions. Our students have done exceptionally well in winning funds to continue the development of their business plans. Some students are discussing licensing arrangements with the university as a prelude to launching their companies. Many WIMS ERC students who are not establishing their own companies are going to work for start-up ventures.

Furthermore, the Center is also involved in supporting local companies, including spin-offs based on WIMS technology. Since its inception, the Center has launched an average of one company per year. Perhaps the most impressive statistic has been that all are still viable and contributing to the economy.

One of the factors that has enabled spin-offs to flourish is the availability of the Michigan Nanofabrication Facility (MNF). The MNF is being expanded with a 37,500-gross-square-foot addition that includes a 4,500 ft^2 additional cleanroom (area under filter) and a 2,800 ft^2 dedicated wet facility. This will increase the size of the cleanroom to ~10,000 ft^2 and upgrade it to 6-inch wafer processing capability.



The MNF allows companies to utilize a world-class facility economically. The expansion will be completed by the end of 2007, with equipment installation in the additional cleanroom area beginning in 2008.

Remember to mark your calendar and attend our October 23–24, 2007, Industrial Advisory Board meeting. Our Web site (www.wimserc.org) has the details.

If you, or one of your colleagues, is interested in sharing your activities with our students, please contact me at either (734) 615-3096 or giachino@eecs.umich.edu to schedule a seminar.

As always, please visit when in the Ann Arbor area so we can share our latest technical developments and progress with the laboratory expansion.

Joseph M. Giachino
Associate Director, Industry

Presentations and Publications (cont.)

IEEE International Solid-State Circuits Conference (ISSCC), San Francisco, California, February 2007

M. Ferriss and M. P. Flynn, "A 14mW Fractional-N PLL Modulator With a Novel Digital Phase Detector and Frequency Switching Scheme"

B. Zhai, D. Blaauw, D. Sylvester, and S. Hanson, "A Sub-200mV 6T SRAM in 130nm CMOS"

DARPA Microsystems Technologies Office Symposium, San Jose, California, March 2007

K. Najafi, "Micromachined Gas Chromatography Microsystem for Complex Gas Analysis," (Invited Talk)

IEEE Southeast Conference 2007, Richmond, Virginia, March 2007

Z. Wang, H. S. Savci, J. Griggs, and N. S. Dogan, "Coping With Process Variations in Ultra-Low-Power CMOS Analog Integrated Circuits"

Publications

A. Astle, H. Kim, L. Bernal, K. Najafi, and P. Washabaugh, "Theoretical and Experimental Performance of a High Frequency Gas Micropump," *Sensors and Actuators A: Physics*, vol. 134, issue 1, pp. 245–256, February 2007.

T. Bansal, M. P. Chang, and M. M. Maharbiz, "A Class of Low-Voltage, Elastomer-Metal Wet Actuators for Use in High-Density Microfluidics," *Lab on a Chip*, vol. 7, pp. 164–166, January 2007.

A. Basu and Y. B. Gianchandani, "Shaping High-Speed Marangoni Flow in Liquid Films by Microscale Perturbations in Surface Temperature," *Applied Physics Letters*, vol. 90, p. 034102, January 2007.

J. Zhang, J. Zhou, and A. Mason, "Highly Adaptive Transducer Interface Circuit for Multiparameter Microsystems," *IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications*, vol. 54, pp. 167–178, January 2007.

T. Li, R. Y. Gianchandani, and Y. B. Gianchandani, "Micromachined Bulk PZT Tissue Contrast Sensor for Fine Needle Aspiration Biopsy," *Lab on a Chip*, vol. 7 (2), pp. 179–185, February 2007.

Michael S. McCorquodale, Justin D. Day, Scott M. Pernia, Gordon A. Carichner, Sundus Kubba, Richard B. Brown, "A Monolithic and Self-Referenced RF LC Clock Generator Compliant With USB 2.0," *IEEE Journal of Solid-State Circuits*, vol. 42, issue 2, pp. 385–399, February 2007.

C. T.-C. Nguyen, "MEMS Technology for Timing and Frequency Control," *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, vol. 54 (2), pp. 251–270, February 2007.

M. P. Rowe, W. H. Steinecker, and E. T. Zellers, "Exploiting Charge-Transfer Complexation for Selective Measurement of Gas-Phase Olefins With Nanoparticle-Coated Chemiresistors," *Analytical Chemistry*, vol. 79, (3), pp. 1164–1172, February 2007.

B. A. Arcand, S. Shyamsunder, and C. R. Friedrich, "A Fluid Actuator for Thin-Film Electrodes," *ASME Journal of Medical Devices*, 1, pp. 70–78, March 2007.

J. Chen, M. P. Flynn, and J. Hayes, "A Fully Integrated Auto-Calibrated Super-Regenerative Receiver in 0.13μm CMOS," *Journal of Solid-State Circuits*, March 2007.

M. D. Johnson, O. E. Kao, and D. R. Kipke, "Spatiotemporal pH Dynamics Following Insertion of Neural Microelectrode Arrays," *Journal of Neuroscience Methods*, vol. 160 (2), pp. 276–287, March 2007.

Doctoral Dissertations

University of Michigan, 2007

Sheng-Shian Li, "Medium-Scale Integrated Micromechanical Filters for Wireless Communications"
Postgraduate Position: Senior Design Engineer, RF Micro Devices, Greensboro, North Carolina
Advisor: Professor Clark T.-C. Nguyen

Rajiv Ravindran, "Hardware/Software Techniques for Memory Power Optimizations in Embedded Processors"
Postgraduate Position: Hewlett Packard Company, Cupertino, California
Advisor: Associate Professor Scott Mahlke

Jianbai Wang, "A Position Sensing System for MEMS-Based Cochlear Prostheses"
Postgraduate Position: Texas Instruments, Dallas, Texas
Advisor: Professor Kensall D. Wise

Bo Zhai, "Ultra-Low-Power Processor Design Using Subthreshold Design Techniques"
Postgraduate Position: Senior Design Engineer, AMD, Austin, Texas
Advisor: Professor David Blaauw

Personnel Focus

Jack Fishstrom has worked for the ERC since 2002, when he first served as an instructor in the Research Experience for Undergraduates summer program. He has fulfilled this important educational role every year since then, lecturing in both technical communication and professional ethics. In addition, he has helped write and edit this newsletter for many years as well. Jack is "on loan" to the ERC from his home base in the Technical Communication Program at the University of Michigan, where he has taught thousands of students over his 15-year career. He currently focuses his teaching efforts in four engineering disciplines: aerospace, chemical, electrical, and nuclear. In addition to covering in his courses all manner of technical writing, he specializes in public speaking and scientific poster design. Jack is also a consulting writer and editor for engineering corporations and medical organizations. For government clients, moreover, he has helped produce training videotape programs. Taking communication to creative heights, Jack wrote and directed a feature film, *Voices*, which satisfied a life-long dream. In addition to four screenplays and several video scripts, Jack's writing portfolio includes brochures, environmental impact statements, legal testimony, magazines, newsletters, patent disclosures, press releases, proposals, remedial designs, software documentation, style guides, and several published journal articles on engineering education. ■

Seminar Series

*** January 16, 2007**
Mark Ferriss and **Bo Zhai**
University of Michigan Graduate Students
"A 14mW Fractional-N PLL Modulator With an Enhanced Digital Phase Detector and Frequency Switching Scheme and a Sub-200mV 6T SRAM in 130nm CMOSS"

*** January 30, 2007**
Professor Mohammed Islam
University of Michigan
"An Engineer's View of Start-Ups"

*** February 6, 2007**
Professor Nikos Chronis
University of Michigan
"Bio-MEMS Tools for Manipulating and Imaging Biological Samples"

*** March 5, 2007**
Scott Reynolds, Ph.D.
IBM
"From Transmission Lines to Transceivers: Silicon Millimeter-Wave ICs for 60GHz and Beyond"

*** March 6, 2007**
Professor Ramakrishna Mukkamala
Michigan State University
"Hemodynamic Monitoring for the 21st Century"

*** March 20, 2007**
Tony Grover
RPM Ventures
"Creating Venture Capital-Backed Companies Based on University Research"

*** March 27, 2007**
Professor Jeyanandh Paramesh
Carnegie Mellon University
"Wireless Communication Circuits in Nanometer CMOS Technologies"

**Available for viewing on website*

Visit our Web site at http://wimserc.org to find out more information about these seminars and to view them on streaming video. You can also see a schedule of upcoming seminars, as well as a listing of publications.

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