WIMS WORLD

University of Michigan | Michigan State University | Michigan Technological University

DIRECTOR'S MESSAGE

Many years ago someone gave me a copy of a 1960 talk entitled "Electronics and Education in the Midwest" by Frederick Emmons Terman of Stanford University. In this talk, Dr. Terman, who is often credited with starting California's Silicon Valley, took aim at the Midwestern electronics industry. Now, you may ask "What Midwest electronics industry?" but in 1960 much of the consumer electronics business of the world was in the Midwest, with companies such as Magnavox, Zenith, and other powerhouses providing the world with radios, televisions, and other products. The article's comments were intentionally provocative and are worthy of repeating here:

"In the last two decades electronics has become one of the most exciting industries of all times because of its diversity, the many challenges it offers, and its potential for spectacular growth. This situation has been brought about by a *new electronics* that originated about 20 years ago, based on sophisticated applications of recent developments in science and technology.

"Education has an increasingly important role in the new electronics. . . . Industry is discovering that for electronic activities involving a high level of scientific and technological creativity, it is more important to be located near an educational institution (a center of brains) than near markets, raw materials, suppliers, transportation, or factory labor. . . . Universities are the sources of the highly-trained young men who represent the most important raw material going into creative electronics. Universities, through their research activities, are sources of ideas; a few of these are directly exploitable commercially, and others contribute to an understanding that stimulates innovation on the part of industry, particularly nearby industry. The faculty members of a good university provides a panel of experts possessing a wide range of highly-developed skills available on a consulting basis to aid industry with its problems; thus even a small company near a university can have access to specialized knowledge in depth on a basis that it can afford. . . . When these factors are viewed in perspective, it is seen that education is perhaps the most significant factor affecting the future of electronics.

"Electronics in the Midwest lacks the explosive character of electronics on the Pacific Coast and in New England. This region does not lead in the development of new ideas and in the opening up of new fronts of activity. . . . In short, the Midwest is still preoccupied with the *old* electronics. . . .

". . . When the war [World War II] brought microwave radar, servomechanisms, sonar, the first solid state devices (diodes) and computers, the electronics industry of the Midwest was unprepared. . . . The lack of scientific depth in Midwest electronics made it difficult or impossible to use fully the region's productive capacity in getting these new devices produced, whereas on the east coast capacity for the items was overtaxed because it was associated with scientific know-how.

"At the end of the war electronics in the Midwest, having been only superficially inoculated with the new ideas that originated in World War II, reverted to its old interests emphasizing the engineering, design, and production of products for the consumer market. This was profitable as long as television was being introduced into new areas, but it had limited opportunity for growth once television was established in every community. In recent years sales of television and radio receivers have not been growing much, and the Japanese may well get an increasing share of the total in the future. . . .

"In contrast with the east and west coasts, the electronics industry of the Midwest has not been much interested in the man with the Ph.D. and what he can contribute to the opening up of new frontiers. It has failed signally to exploit the educational resources and the educational institutions that are available to it. . . .

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INSIDE

"To be brutally blunt, the major path of electronics took off in a new direction in the decade of 1940–50, but little of the electronics industry of the Midwest followed. . . .

". . . In broad terms, the Midwest is more interested in the man with practical know-how than in the man whose strength is depth of training in advanced science and technology. . . . As a result, the midwest companies don't really fight for the men with advanced degrees in electronics being produced by their own universities, let alone by universities in other parts of the country. . . . The electronics industry in the Midwest has not adequately appreciated the importance of the educational institutions that are in its midst, and has not made full use of them. It is surprising that there are not more electronic companies of the creative type clustered around outstanding midwestern universities. This is the result of both lack of vision on the part of industry and lack of leadership on the part of the educational institutions.

"These remarks have deliberately attempted to be provocative. The electronics industry of the Midwest is in a rut and needs to be jolted out of it. It lacks the glamour and the growth potential that it should have. Electronics in the Midwest has a long tradition and a successful past. It can have a worthwhile future, and can participate more in the good new things that are ahead in the field of electronics during the next several decades, but only by developing with the times. If it just plods along, the Midwest will become increasingly the peon group in the electronics industry, which does hard, unexciting work and makes a living, while at the same time the east coast and particularly the west coast electronics industries will have all of the fun and most of the growth. If the Midwest continues in the present pattern, it will continue to be the happy hunting ground where bright young people are recruited to go to the east and west coasts to make the electronics industries there steadily stronger and ever growing."

Now we are engaged in creating a still newer electronics—that of microsystems. It merges micropower circuits and wireless interfaces with microelectromechanical systems (MEMS) and advanced packaging. Like the microelectronics of 1960, microsystems are a hot topic today and something that the Midwest has been a leader in, at least insofar as MEMS is concerned. But as microsystems are developed and used to realize innovative new products, can we catalyze a Microsystems Valley in the Midwest? Much of what we are doing in the WIMS ERC could certainly contribute to that. But faculty members, industrial personnel, and state leaders should all read Dr. Terman's remarks* carefully as we chart a course for doing it. Many of his comments could apply to just about any emerging high-tech field. We've got to catch the excitement and the possibilities of this new area, drive it forward aggressively, and be prepared to take some chances. We've got to think a lot bigger about things that are a lot smaller—especially in the Midwest!

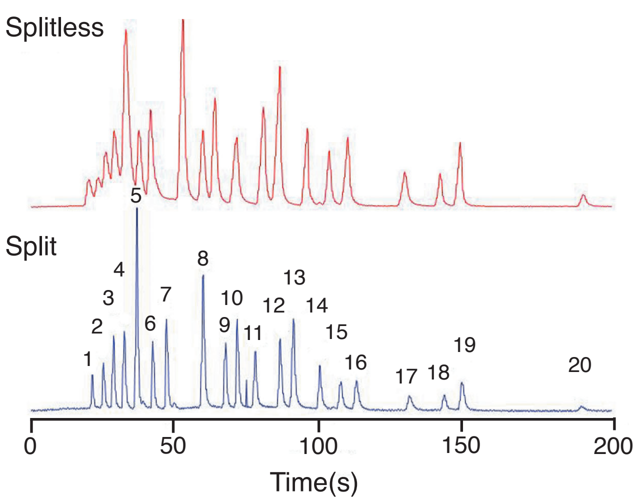
Ken D. Wise

Director, Engineering Research Center for
Wireless Integrated MicroSystems

*The talk can be found in its entirety in *The Michigan Economic Record*, January 1961.

RESEARCH HIGHLIGHTS

IMPROVING RESOLUTION OF GAS CHROMATOGRAPH THROUGH SPLIT-FLOW OPERATION



The separation of a 20-component mixture using splitless and split operation. An 8m length of 0.25mm i.d.-fused silica column coated with a 0.25mm film of trifluoropropylmethyl polysiloxane was used for the separation column.

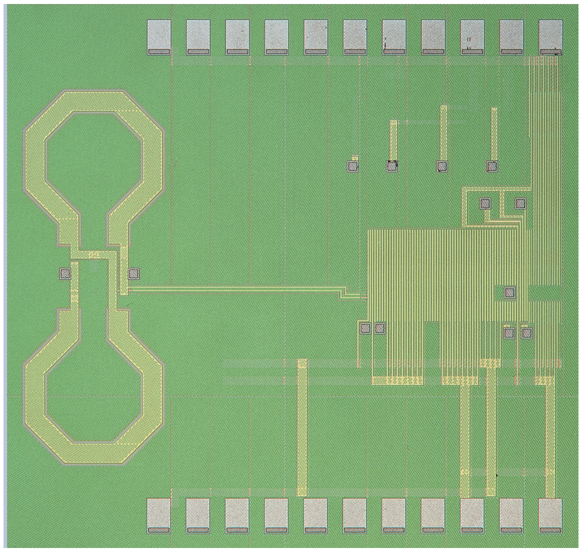
In order to improve the resolution of portable gas chromatograph systems, researchers at the Center are exploring the idea of using the preconcentrator as an inlet with split-flow operation. This approach should reduce band broadening, thereby increasing the resolution.

Band broadening in the preconcentrator is due to two problems: desorption kinetics and dead volumes—volumes that must be swept by the carrier gas, but do not contribute to component separation. The problem of desorption kinetics can be significantly decreased by rapidly heating the preconcentrator. To correct the problem of dead volumes, the flow of carrier gas through the preconcentrator can be increased.

However, increased carrier gas flow through the separation columns increases band broadening due to mass transport mechanisms in the mobile and stationary phases. Gas compression effects, at the higher pressure drops required for the increased carrier gas velocities, also increase band stretching of the injection plug as it enters the separation column.

To correct these difficulties, researchers are exploring split-flow operation. Based on a typical split inlet, roughly 90% of the carrier gas flow coming out of the preconcentrator is siphoned off to a vent and about 10% is directed into the separation column. This produces a significantly narrower injection plug, generating greatly enhanced system resolution.

NEW CLOCK GENERATION PRESENTS ALTERNATIVE TO BUFFER-DRIVEN CLOCK NETWORK


A distributed LC circuit. The inductors and transistor of the BCO can be seen at left. The clock distribution network of the scan-chain is on the right.

In typical clock generation and distribution networks, the clock source is amplified through a series of buffers to drive the large capacitive load of the clocked logic, while providing minimal skew and jitter. However, typical clock networks dissipate a lot of power and are complicated to design. A new type of clock generation and distribution scheme recently designed at the Center removes the buffers and resonates the clock energy between the clock source and clocked logic, resulting in a 35% reduction in power over a buffer-driven clock.

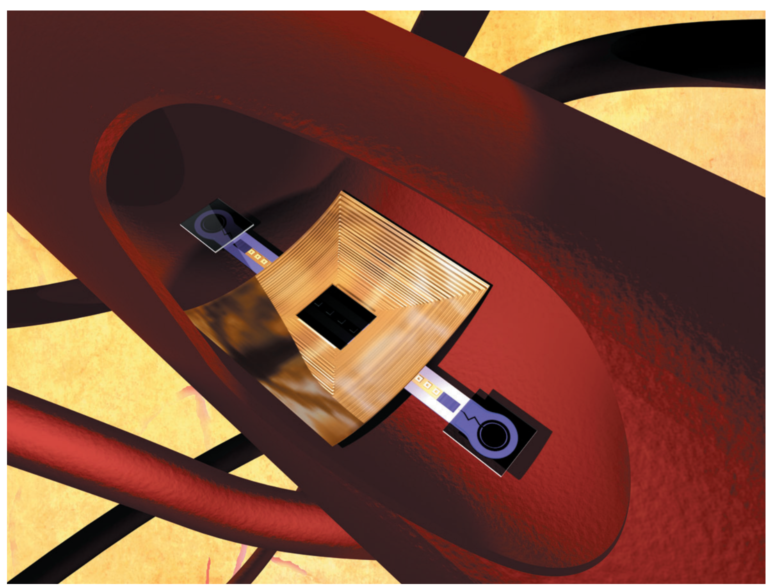
This resonant clock generator works by utilizing the gate and wire capacitance of the clock load as the capacitive storage element in an inductance capacitive, harmonic resonator. The clock load consists of three 8 x 64 bit scan-chains representing the clock load of a functional unit in a microprocessor. By including the gate capacitance within the resonator, clock generation and distribution can occur concurrently, allowing the circuit to naturally oscillate at its most efficient frequency.

The first generation of the resonant clock scheme unveiled several possibilities and challenges. The clock period jitter, measured at 0.68% of the 124MHz clock, is stable in spite of data flowing through the clocked logic. Power savings of 35% were also measured. The biggest design challenge is reducing the resistance and increasing the capacitance of the clock distribution network. The parasitic resistance, in particular, limits the power savings and oscillation frequency of the resonant clock. A second generation of the resonant clock is under development to reduce the parasitic resistance of the network, thus improving the power savings and increasing the oscillation frequency into the GHz range.

PRESSURE-MEASUREMENT SYSTEM DETECTS DECREASED INTRA-ARTERIAL FLOW

When inserting a stent into an artery to increase arterial flow after removing plaque build-up, there is a risk of restenosis—the recurrent narrowing of the artery after surgery. Currently, the only method for diagnosing this problem is catheterization—inserting a long, hollow tube into the artery.

As an alternative to this procedure, researchers are now exploring a new option to detect restenosis. By placing sensors within the stent itself, doctors will be able to diagnose any reduction in intra-arterial blood flow caused by the onset of restenosis.


A rendering of the two-site pressure-measurement system lodged inside an artery. Through wireless data transmission, this device monitors changes in intra-arterial blood flow, a way to detect restenosis.

These sensors create a two-site wireless differential pressure-measurement system that can be implanted during stenting or vein grafting procedures. The system implements an on-chip antenna that conforms to the wall of the artery and can identify a 13% reduction of blood flow in vessels the size of the carotid artery, a differential pressure of 3mmHg.

By utilizing transcutaneous power delivery—delivery of power through the skin—from an external system, the life of the battery-free flow-monitoring system is essentially unlimited. Realized on a monolithic substrate, the system consumes 340μW and uses capacitance-to-frequency conversion for readout of the vacuum-sealed pressure transducers. This two-site wireless pressure-measurement uses a backscatter-modulated passive-telemetry interface with a vertical footprint of 200μm and a volume of 2mm^3.

RECENT EVENTS

WIMS RESEARCHERS ATTEND IEEE INTERNATIONAL MEMS CONFERENCE IN NETHERLANDS

University of Michigan students, faculty, and alumni were present in force at the recent *IEEE International Conference on Micro Electro Mechanical Systems (MEMS'04)* held in Maastricht, The Netherlands. Pictured here with conference co-chair Professor Paddy French of Delft University, the group met for dinner at a restaurant near the city hall. In its 17th year, the MEMS conference has evolved into one of the premier meetings in this technical area. The presentations from UM covered a variety of topics, ranging from biomedical wireless sensors and chemical sensors to microfabrication and micropackaging technologies.

150 YEARS OF ENGINEERING EXCELLENCE CELEBRATED AT RESEARCH EXHIBIT

As part of the celebration of the University of Michigan's 150 years of engineering excellence, the College of Engineering organized a research exhibit in the Capitol Rotunda, Lansing, Michigan, on March 25, 2004 to highlight the areas of innovative engineering expertise. Explaining the research being developed at the WIMS ERC was WIMS Associate Director of Industry, Joe Giachino, who presented the various advances this Center has engineered to improve the quality of life. The presentation highlighted not only the micro and nanotechnology being developed, it also emphasized the economic impact of the WIMS ERC.

WIMS GRADUATE STUDENT HONORED WITH PRESTIGIOUS NSF FELLOWSHIP

Robert Franklin was recently awarded a National Science Foundation (NSF) Graduate Research Fellowship. One of the most prestigious awards in engineering and science, this was given to 900 of the top Ph.D. graduate students in the country. By earning this award, Rob has secured three years of support from the NSF to be used over the next five years. NSF will pay for his graduate work and schooling, including a stipend for living expenses. Congratulations Rob!

PERSONNEL FOCUS

Joshua J. Whiting of Sandia National Laboratories was recently appointed as a system integrator for the WIMS ERC—a two-year appointment. Joshua has the opportunity to continue work begun during his doctoral program by helping the Center develop the micro gas chromatograph. Joshua received his M.S. in chemistry from Wright State University in Dayton, Ohio, in 2000, where his research focused on the analysis of trace levels of low molecular weight organic acids in natural and created wetlands. Following the completion of this research, he entered the Ph.D. program in analytical chemistry at the University of Michigan where he worked on a collaborative effort to design and build a portable gas chromatograph for indoor air quality monitoring. His work focused on methods to enhance the performance of the instrument, enabling faster separations by using the available peak capacity as efficiently as possible. Joshua's research interests include GC development and miniaturization.

EDUCATION HIGHLIGHTS

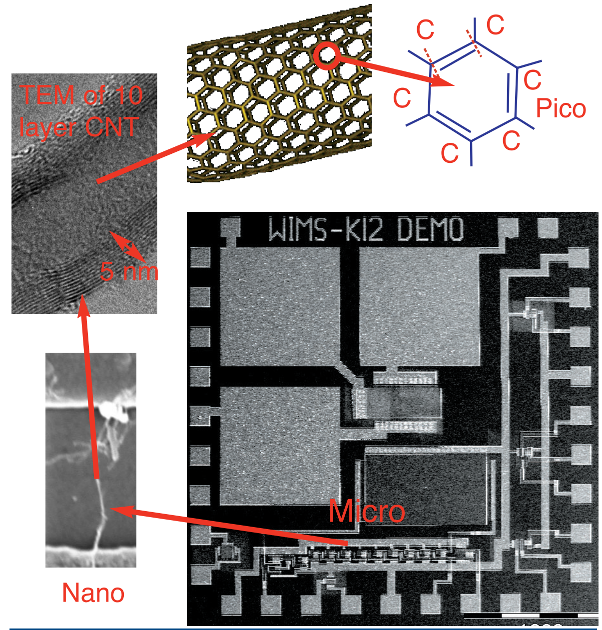
K–12 STUDENTS LEARN ABOUT NANOTECHNOLOGY USING WIMS CHIP AND NANOTUBES

The "From Kindergarten to Ph.D.,"or K–Ph.D., program is teaching various students kindergarten through community college age about science and engineering through hands-on, WIMS-based examples. Students have built robots and other mechanisms to learn scientific and engineering principles appropriate for their age.

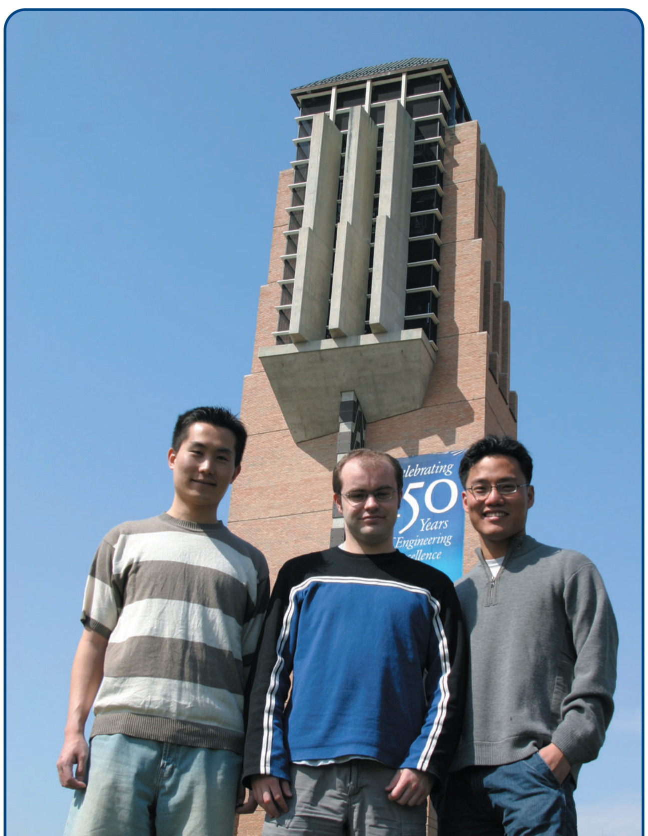
More recently, K–Ph.D. has added nanotechnology to its agenda. In order to facilitate understanding, students are taught by first examining larger objects they can handle and see. As the class progresses, objects become smaller until students need high-magnification microscopes to see the details.

The culmination of this top-down method is a K–12 microchip designed by the K–Ph.D. team at Michigan State University. The current design uses a millimeter-size MOS transistor, followed by a similar micron-size device. Finally, carbon nanotubes are present on the chip that are too small to be seen in visible light.

The chip was fabricated as part of the microsystems fabrication course (EECS 425) at the University of Michigan, creating a unique link between WIMS research, graduate courses, and K–12 activities. A second generation chip with more nanostructures, including sensors, is currently being fabricated as part of the Spring 2004 EECS 425 class.



Top left: A portion of a carbon nanotube laced on the chip. Bottom right: MSU-designed chip for nanotubes.



From left: Joshua Kang, Mark Ferris, and Junghwan Han.

WIMS STUDENTS' PROJECT VOTED WINNER IN EECS CLASS STUDENT DESIGN CONTEST

In a newly updated EECS 413 class, students were awarded $100 towards the purchase of their textbooks in a design contest. Voted as the winners by fellow students, Mark Ferris, Joshua Kang, and Junghwan Han received the award for their project, "A Low-Voltage Rail-to-Rail 100MHz Operational Amplifier."

Although it is not a permanent addition to the curriculum, Professor Michael Flynn added this contest, along with several other revisions, to EECS 413. This class is now completely revised to be an up-to-date introduction to CMOS analog and mixed-signal design. It also meets the requirements for an undergraduate major design experience. Students, such as Mark, Joshua, and Junghwan, must complete a significant design project, where they work in groups and present circuits designed in 0.25μm CMOS.

For the first time, this course also incorporates custom analog layout, along with DRC, LVS, and resimulation with parasitics using complete industrial tools. Advanced topics such as switched capacitor circuits are also discussed.

Thanks to the extensive efforts of WIMS Summer Programs Director Drew Kim (MSU), WIMS-focused summer programs are increasing in popularity and the quality of students. This year, programs held at MSU received more applicants than any other university offering similar age-based programs. Success is due to the various seminars and fairs where Kim has spoken, highlighting the exciting work done with WIMS-focused programs.

STUDENT LEADERSHIP

NEW PRESIDENCY FOLLOWS FOOTSTEPS OF PAST—COMBINING STUDIES AND SERVICE

New SLC presidency, from left to right: Luciana da Silva, Jay Mitchell, Neil Welch, Joe Potkay, and Helena Chan. Not pictured: Willie Steinecker.

Winter semester began with the Student Leadership Council (SLC) officers taking their new positions: Joe Potkay, president; Neil Welch, vice president; Helena Chan, industrial chair; Luciana da Silva, educational chair; and Jay Mitchell, social chair. In addition, a new officer position was created, where Willie Steinecker was elected, with the responsibility of coordinating university activities. At Michigan State University, Nelson Sepulveda-Alancastro is the SLC chair with Tania Yusaff as the assistant chair. At Michigan Technological University, Sudeep Shyamsunder is the SLC chair with Shailesh Gugale as the assistant chair.

In January, members of the educational committee met with the staff of the Hands-On Museum in Ann Arbor to brainstorm and plan the future direction of the cochlear implant exhibit. Work will continue on the floor exhibit, but in addition, an interactive version of the exhibit will be available on the museum's Web site, including the cochlear matching game designed by a University of Michigan graduate student.

In February, the SLC once again sponsored an emergency blood drive at the request of the Red Cross. The WIMS SLC responded to the request by collecting 36 pints of blood to help mitigate the blood shortage in southeastern Michigan. Thanks to all who donated blood and/or volunteered time. Also, the social committee arranged a movie night and coordinated intramural sports teams to further increase interaction and friendship among WIMS students.

In March, the annual WIMS DAPCEP program began, with SLC students volunteering their Saturdays to teach Detroit-area teens about WIMS using electronics and LEGO Robotics Mindstorm Invention kits. At MSU, SLC students focused their efforts, January through March, on teaching elementary and middle school age children how to build, design, and construct robots in the K–12 program. To help promote student participation in the May IAB meeting, Sudeep Shyamsunder at MTU helped organize rides to the meeting.

At the request of the SLC, a patent seminar, as part of the WIMS Seminary Series, was arranged by Joe Giachino. The Office of Technology Transfer's Director of Licensing, Robin Rasor, spoke on intellectual property protection, and it was a huge success.

INDUSTRIAL LIAISON'S REPORT

In discussions with a few of my industrial colleagues, I realized that some are not aware of the advantages of an Engineering Research Center environment. Because ERCs take a systems approach, they require experts from a variety of disciplines to be involved. This large cross-section of talent allows ERC members to take advantage of a pool of talent not readily available in other organizations. Still, I see many companies and their engineers attempting to select "the professor" they want to deal with and establish a technical relationship with that individual faculty member. With ERCs, I believe you have that rare opportunity to "have your cake and eat it too." A company can still develop close relationships with individual researchers, but also have access to a large and varied technical cadre. The individual relationship historically is the tried and true formula, and when academic research was made up of small, unconnected islands of expertise, it was probably the only relationship model feasible. However, with the birth of the National Science Foundation ERCs, this old, individual-only model is as effective as a prop plane in the jet era. Companies driven to respond to the ever-shorter development cycles realize they need the combination of breath and depth of talent uniquely available in ERCs. With over 39 core faculty, 237 students, and 132 projects, the WIMS ERC offers our members that opportunity.

Our next Industrial Advisory Board meeting is May 11 and 12; I encourage you to attend. However, whenever you are in the Ann Arbor area, please stop at the Center to get an update on our projects. Contact me if you would like to review any of our research in detail.

Joseph M. Giachino
Associate Director Industry

SEMINAR SERIES

January 13, 2004
Professor Michael Perrott
Massachusetts Institute of Technology
Design and Simulation of Phase Locked Loops

January 20, 2004
Shamus McNamara, PhD, Ken´ichi Takahata
PicoCol, Inc. and UM
Ann Arbor, MI
Ultracompliant Passively Decoupled Thermal Probes: Large Area Mapping of Non-Planar Surfaces Without Force Feedback/A Wireless Microsensor Utilizing a Micromachined Antenna Stent and Pressure Sensors for Monitoring Flow and Pressure in a Blood Vessel

February 02, 2004
Sunit Rikhi
Intel Corporation
Hillsboro, OR
Challenges in Integration of Nanoscale Technology and VLSI Design

February 10, 2004
Professor Numan Dogan
North Carolina A&T State University
Low-Power UHF Receiver Implemented in 0.35-µm SOI CMOS

February 17, 2004
Professor Jerome Peter Lynch
University of Michigan
Wireless Sensors for Monitoring Smart Civil Structures: An End Users Perspective

March 2, 2004
Professor Yu-Chong Tai
California Institute of Technology
Parylene for MEMS Applications

March 4, 2004
David Amm
Silicon Light Machines
Grating Light Valve™ Technology and Applications

March 9, 2004
Robin Rasor, Director of Licensing
University of Michigan
Intellectual Property Protection

March 16, 2004
Professor Mingyan Liu
University of Michigan
Networking with Low Duty-Cycled Wireless Sensors

March 22, 2004
Stacy Ho
Analog Devices
ADC Design: Real Life Applications, Problems, and Solutions

March 23, 2004
Thomas George, PhD
Supervisor, MEMS Technology Group—NASA/Jet Propulsion Laboratory
Pasadena, CA
Challenges with MEMS/NEMS Technology Development for Space Applications at NASA/JPL

March 30, 2004
Professor Ali Niknejad
University of California, Berkeley
Wireless Communication: Systems, Circuits, and Devices

PRESENTATIONS/ PUBLICATIONS

17th IEEE International Conference on Micro Electro Mechanical Systems (MEMS'04), Maastricht, The Netherlands, 2004

B. Stark and K. Najafi, "A Mold and Transfer Technique for Lead-Free Fluxless Soldering and Application to Wafer-Level Low-Temperature Thin-Film Packages"

C. Wilson and Y. Gianchandani, "Room Temperature Deposition of Silicon by Arrayed DC Microplasmas"

H. Kulah and K. Najafi, "An Electromagnetic Micro Power Generator for Low-Frequency Environmental Vibrations"

J. Chae, B. Stark, and K. Najafi, "A Micromachined Pirani Gauge with Dual Heat Sinks"

J. Wang, J. Butler, T. Feygelson, and C. Nguyen, "1.51-GHz Polydiamond Micromechanical Disk Resonator with Impedance-mismatched Isolating Support"

K. Takahata, A. DeHennis, K. Wise, and Y. Gianchandani, "A Wireless Microsensor for Monitoring Flow and Pressure in a Blood Vessel Utilizing a Dual-Inductor Antenna Stent and Two Pressure Sensors"

K. Udeshi and Y. Gianchandani, "A DC-Powered, Tunable, Fully Mechanical Oscillator Using In-Plane Electrothermal Actuation"

L. Que, K. Udeshi, J. Park, and Y. Gianchandani, "A Bi-Stable Electrothermal RF Switch for High Power Applications"

S. McNamara, A. Basu, J. Lee, and Y. Gianchandani, "Ultracompliant, Passively Decoupled, Thermal Probe Arrays: Large Area Mapping of Non-Planar Surfaces Without Force Feedback"

S. Mutlu, F. Svec, C. Mastrangelo, J. Frechet, and Y. Gianchandani, "Enhanced Electro-Osmotic Pumping with Liquid Bridge and Field Effect Flow Rectification"

S. Li, Y. Lin, Y. Xie, Z. Ren, and C. Nguyen, "Micromechanical Hollow-Disk Ring Resonators"

Austin Conference on Energy-Efficient Design (ACEED 2004), Austin, TX, 2004

J. Sivagnaname and R. Brown, "Effect of Scaling on Stand-by Current in PD-SOI Pseudo-nMOS Circuits"

R. Rao, K. Agarwal, D. Sylvester, R. Brown, K. Nowka, and S. Nassif, "Approaches to Run-time and Standby Mode Leakage Reduction in Global Buses"

Fifth Annual Austin Center for Advanced Studies Conference, Austin, TX, 2004

A. Drake and R. Brown, "Performance Impact of Gate-Body Signal Phase on DTMOS Inverters"

R. Rao, R. Brown, K. Nowka, and J. Burns, "Analysis and Mitigation of CMOS Gate Leakage"

IEEE International Solid-State Circuits Conference (ISSCC-2004), San Francisco, CA, 2004

K. Wise, K. Najafi, R. Sacks, and E. Zellers, "A Wireless Integrated Microsystem For Environmental Monitoring"

M. Ghovanloo and K. Najafi, "A Modular 32-site Wireless Neural Stimulation Microsystem"

Y. Lin, S. Lee, S. Li, Y. Xie, Z. Ren, and C. Nguyen, "60-MHz Wine Glass Micromechanical Disk Reference Oscillator"

2nd WiOpt: Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks, Cambridge, UK, 2004, E. Duarte-Melo, M. Liu, and A. Misra, "A Modeling Framework for Computing Lifetime and Information Capacity in Wireless Sensor Networks"

2004 Nanotechnology Conference and Trade Show, Boston, MA, 2004, S. Martin, T. Strong, F. Gebara, and R. Brown, "Mixed-Domain Simulation of Step-Functional Voltammetry with an Insoluble Species for Optimization of Chemical Microsystems," to be published.

NAMEPA Conference, Lake Buena Vista, FL, 2004, P. Farrell, C. Friedrich, D. Kim, and L. McAfee Jr., "Winning with WIMS: Creative Strategies for University/Government/Industry Collaborations"

The International Conference on VLSI Design (VLSI Design 2004), Mumbai, India, 2004, R. Rao, J. Burns, and R. Brown, "Analysis and Optimization of Enhanced MTCMOS Scheme"

The National Radio Science Meeting (URSI), Boulder, CO, 2004, N. Behdad and K. Sarabandi, "A Novel Quad-pole Antenna with Very Large Bandwidth," second place in student paper competition

Analytical Chemistry, 2004, G. Lambertus, A. Elstro, K. Sensenig, J. Potkay, M. Agah, S. Scheuering, K. Wise, F. Dorman, and R. Sacks, "Design, Fabrication, and Evaluation of Micro-Fabricated Columns for Gas Chromatography"

Electrophoresis, 2004, B. Kirby and E. Hasselbrink, “The Zeta Potential of Microfluidic Substrates 1: Theory, Experimental Techniques, and Effects on Separations,” vol. 25, pp. 187–202.

Electrophoresis, 2004, B. Kirby and E. Hasselbrink, “The Zeta Potential of Microfluidic Substrates 2: Data for Polymers,” vol. 25, pp. 202–213.

IEEE/ASME Journal of Microelectromechanical Systems (JMEMS), 2004, A. Wong and C. Nguyen, “Micromechanical Mixer-Filters (‘Mixlers’),” vol. 13, no. 1, pp. 100-112.

IEEE Transactions in Biomedical Eng., 2004, R. Rathnasingham, S. Bledsoe, J. McLaren, and D. Kipke, “Characterization of Implantable Microfabricated Fluid Delivery Devices,” vol. 51, no. 1, pp. 138–145.

International Journal of Heat and Mass Transfer, 2004, L. da Silva and M. Kaviany, “Micro Thermoelectric Cooler: Size Effects on Thermal and Electrical Transport,” vol. 47, no. 10–11, pp. 2417–2435.

Journal of Occupational and Environmental Hygiene, 2004, M. Hsieh and E. Zellers, “Adaptation and Evaluation of a Hand-held 'Electronic Nose' for Selective Multi-Vapor Analysis,” vol. 1, pp. 149–160.

Sensors and Actuators B – Chemical, 2004, J. Min, E. Hasselbrink, and S. Kim, “On the Efficiency of Electrokinetic Pumping of Liquids Through Nanoscale Channels,” vol. 98, no. 2–3, pp. 368–377.

DOCTORAL DISSERTATIONS

Brian Stark
“Thin Film Technologies for Hermetic and Vacuum Packaging of MEMS”
University of Michigan, 2004
Advisor: Professor Khalil Najafi

Joshua Whiting
“Techniques for Thermal and Pneumatic Programming of Column Selectivity and Methods for Reducing the Impact of Extra-Column Band Broadening on System Performance”
University of Michigan, 2004
Current Position: Systems Integrator, WIMS ERC; Limited Term Technical Staff Member, Sandia National Laboratories, Albuquerque, NM
Advisor: Richard D. Sacks

Hao Yu
“A Wireless Microsystem for Multichannel Neural Recording Microprobes”
University of Michigan, 2004
Advisor: Professor Khalil Najafi

MEMBER COMPANIES

Ardesta, LLC
Chevron Texaco Corporation
Corning, Inc.
Delphi Corporation
Dexter Research Center
Discera, Inc.
EDF Ventures
EV Group, Inc.
Honeywell International
Intel Corporation
ISSYS, Inc.
Mobius Microsystems
Motorola, Inc.
Samsung Electronics
Sensicore, Inc.
SUSS MicroTec, Inc.
Texas Instruments, Inc.
Sandia National Labs
MEDC

Schedules of upcoming seminars as well as a listing of publications are available at www.wimserc.org.

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