2008

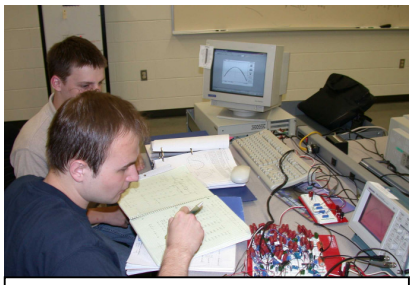
2007/08 Research, Development, and Activities

College of Engineering and Applied Sciences

ECE DEPARTMENT
2007/08 RESEARCH, DEVELOPMENT, AND ACTIVITIES

Nonlinear Circuits and Systems: Drs. Bazuin, Miller, and Severance, in collaboration with Dr. Giuseppe Grassi of the University of Salento, Italy, continue to investigate the theory and engineering applications of chaotic systems.

A senior design group (C. Bommarito, P. Kokeny, and D. Squires) realized an electronic implementation of a chaotic circuit proposed in the paper "Generation of a four-wing chaotic attractor by two weakly-coupled Lorenz systems" by Grassi, Severance, Mashev (ECE graduate student), Bazuin, and Miller to appear in the journal *International Journal of Bifurcation and Chaos*. The resulting circuit design is being refined in preparation for submission of a scholarly article. The members of that senior design group, along with ECE students D. Kirklewski and J. Stahl, presented their work in chaotic circuits at the 2007 NASA Michigan Space Grant Consortium (MSGC) conference. D. Squires' research on utilizing chaotic signals in a communication system is supported by the MSGC via an undergraduate research fellowship.



Donovan Squires and David Kirklewski working in a research lab on a chaotic logistic map circuit.

The paper "Multi-wing hyperchaotic attractors from coupled Lorenz systems" by Grassi, Severance, and Miller will appear in the journal *Chaos, Solitons, and Fractals*. In addition a paper entitled "Arbitrary observer scaling of all chaotic drive system states via a scalar synchronizing signal" by Grassi and Miller will also appear in the journal *Chaos, Solitons, and Fractals*.

Computing with Neuron Cell Cultures: Drs. Bazuin, Gesink, Miller, and Severance are starting a research program to study biological neural networks as computing devices using multi-electrode arrays. A $10,000 Western Michigan University Faculty Research and Creative Activities Support Fund grant entitled *Computing with Neuron Cell Cultures* (awarded to Dr. Severance) and the College of Engineering and Applied Sciences is supporting setup of a suitable laboratory. Two senior design groups (E. Armstrong, N. McCaskey, J. Parackal John, A. Ranganathan, P. VanDeusen, and S. Westbrooks) developed prototype circuitry for measurement and stimulation of cell culture electric potentials; this work was presented at the 2007 NASA Michigan Space Grant Consortium conference. Another senior design group (T. Caruso, E. Daiek, and E. Jones) is working to refine this prototype for use this summer. The MSGC is supporting this work via research fellowships for E. Armstrong, S. Westbrooks, and M. Ellinger (ECE graduate student). Armstrong and McCaskey were supported by Western Michigan University Undergraduate Research and Creative Activities Awards.

Dr. Severance with Josh Armstrong during dissection of an earthworm in preparation for recording giant axon action potentials.

Senior design groups involved in research work. Left: Bommarito, Squires, and Kokeny; middle: Armstrong, Parackal John, and McCaskey; right: Ranganathan, Westbrooks, and VanDeusen.

Rehabilitation Engineering - The major thrust of activity in these studies relates to veering of visually impaired individuals. Veering is the drift from ones intended path of travel and it happens to most persons when position feedback is absent. One of the major efforts in these studied has been the development of a device to train blind individuals to better walk a straight path without veering in short missions such as crossing a street or walking across a parking lot. Such a device, an Anti Veering Training Device (see Photo), has been developed and is waiting field-testing. Other activity in this area focuses on the development of a Veer Analyzer, a device which, when coupled to a veering individual, will measure and record, in two dimensions, the trajectory of the individuals movement. The recorded trajectory is then analyzed in an effort to decompose the trajectory into a rotational and a translational component. If successful, the analysis will be useful in developing programs to reduce veering. Thus far, hardware has been developed to record the trajectory and progress is being made on analytical techniques to extract the rotational and translational components. John Gesink heads this effort and the National Institute of Disability Rehabilitation and Research funds it. (Gesink)

Cooperative Localization and Communication via Indoor Wireless Networks
Indoor positioning and indoor ad hoc communication networking are key technologies of many wireless applications inside buildings. The major difficulty imposed on these technologies lies on the harsh indoor radio propagation environment. A complicated multipath propagation link usually exists between the transmitter and the receiver that makes the network localization prone to error and the traditional cooperative communication unreliable. This research proposes a novel scheme of implementing indoor localization with cooperative communication. They assist each other in achieving both precise node localization and power-efficient communication. (Liang Dong. Supported by the Michigan Space Grant Consortium and by the WMU Research Development Award)

Wireless Communications over Time-Varying Channels
This project analyzes the impact of time varying channels (time variation could arise from Doppler effects or frequency offsets) to the broadband multimedia wireless communications systems. Such channel condition is common in the scenario of mobile ad-hoc networks (MANET) or vehicular ad-hoc networks (VANET). Turbo equalization with iterative channel estimation is implemented, and multiple antenna techniques are used for the inter-carrier-interference mitigation. (Liang Dong)

Development of an Intelligent Vehicle Health Management System for Light Tactical Vehicles – The Army is poised to introduce Condition Based Maintenance (CBM) across its land-based vehicle fleet. CBM is expected to increase the vehicles' readiness and operational availability and reduce the solders' maintenance burden. In this research we will begin to develop an intelligent vehicle health management system for light tactical vehicles. The focus will be on vehicle systems as follows: engine, engine coupling, transmission, drive shaft system, differential and axle, and wheels and tires. We will also develop a secure vehicle identification method through RFID technology. The front-end of our vehicle health management system will have the following elements: data acquisition, data manipulation, condition monitoring, health assessment (diagnostics) and prognostics. The project is funded by TARDEC through CAViDS. (Janos Grantner, Bradley Bazuin, Liang Dong and Richard Hathaway, of the MAE Dept.)

TS-Type Automaton for Software Agents – In this project our objective is to develop a new, Takagi-Sugeno type fuzzy automaton. Tracking the status of an event driven, large control system is a difficult problem. Those systems often encounter unexpected events in an uncertain environment. The use of fuzzy automata offers an effective approximation method to model continuous and discrete signals in a single theoretical framework. A Max-Min automaton can successfully model a cluster of relevant states when a decision is to be made on the

next state of a goal path at the supervisory level. However, to provide analytical proof for stability and other key properties for inference performed by a fuzzy controller the Takagi-Sugeno model is preferred. This project is a continuation of a previous one referred to as Generic Encapsulated Fuzzy Automaton Software Agent. (Janos Grantner and George Fodor, of ABB Automation Technologies, Sweden).

Swarm Behavior - This project focuses on the programming of multiple mobile robots to seek goals and avoid obstacles through concerted effort. All of the robots have onboard infra-red sensors, which are used for obstacle detection. These sensors are also then used for inter-robotic communications. Anticipated applications range from bio-medical to transportation. This is an internally funded project. (Tanner)

Expanding Your Horizons @ WMU Engineering

WMU students who assisted the program include CCE majors Joseph Barbera, Brad Stempihar, and Ammar Zalt; ECE majors Ishrak Mamun, Ivana Krenata, Eddie Quada, and Bryan Berger; ECE Ph.D. student Imad Zyout; and Kalamazoo Area Math and Science Center volunteer Omar Abudayyeh.

The program was directed by Dr. Ikhlas Abdel-Qader, an associate professor in the ECE department as part of a $245,000 grant from the WMU President's 2005 Innovation Fund for the project, "WMU-Kalamazoo Promise Partnership: Promoting Engineering Careers to Female, Minority and Economically Disadvantaged Middle School Students." Dr. Sherif Yehia, a CCE associate professor, and Dr. Edmund Tsang, associate dean of CEAS, are cocontributors to the project.

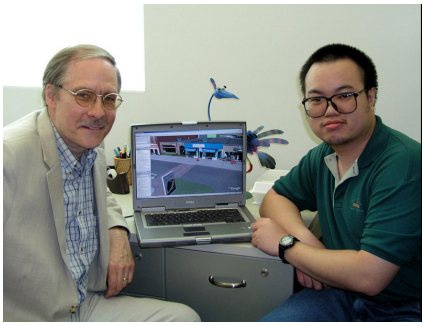
Dr. Atashbar presented a three days short course for research scientist and engineer at NASA Langley Research center Hampton, Virginia from July 17-19 2007. The theme of workshop was centered on **Transmission Matrix Modeling** of acoustic wave based sensors. In this course, three different configurations of the surface acoustic wave (SAW) devices: delay line, one-port resonator, and two-port resonator were introduced. Both the equivalent circuit and transmission matrices modeling approach for the SAW devices will be presented. Creation and use of the extended transmission matrices method, for delay lines and resonators as well as S network parameters (S11, S12, S21, S22) will be discussed.

Dr. Atashbar is currently on sabbatical leave to support his research activities based on a proposal entitled "**MEMS-based Energy Scavenging and Power Generation**". As ultra-low-power circuits and microsystems developing conventional batteries used for these systems could be replaced with smaller-sized and longer-lifetime alternatives. In this sense, energy harvesters hold great advantages such as unlimited life-time, and no need for recharging or power cables. Mechanical energy harvesters are especially useful for environments that are exposed to external vibration and forces, like the wing of an insect. The goal of this research is to develop an efficient microscale power generator that harvests energy of >50μW within a volume of <0.01cc and a weight of <0.2g from live beetles as a part of the DARPA HI-MEMS (Hybrid Insect) Project. (Collaborating with Professor Khalil Najfi at the University of Michigan).

Dr. Atashbar is working on Development of **hybrid guided shear horizontal surface acoustic wave sensor instrumentation system** for the detection of serum protein biomarkers. This project is seed funded by Technology Development Fund and is collaborat1/10/2008- 12/1/2008, $19,000.ing with Dr. Bruce Bejcek at biology department.

Future tourism to reap rewards of virtual South Haven project

In the future, West Michigan vacation spots will be easier to locate and more familiar thanks to a project that uses virtual 3D technology to link Google Earth to travel Web sites. The new technology is being developed by **Dr. Dean Johnson**, a professor in the Department of Electrical and Computer Engineering (ECE), and **Sithidej Damrithamnij** (Dej – pronounced Desh), a WMU graduate who recently earned both electrical and computer MS degrees. For the pilot study, a virtual environment was constructed for South Haven, a small Lake Michigan town. "The project involved building a virtual community on Google Earth and then interfacing the system to the major South Haven travel Web site to enable people to visualize and explore the community through links on the Web site," Johnson said. "The program is very sophisticated and very futuristic." Johnson credited Dej, who is from Thailand and who completed "excellent work" in Johnson's Spring 2005 ECE 6950 Virtual Reality Projects class, for the excellent 3D images. "He was the best student in my class, so I hired him," Johnson said. "He built the entire structure." The project involves not just the usual satellite mapping on Google Earth, but also Google Earth's 3D street-level visualization capabilities. For the virtual realm, Dej created 3D hotspots of South Beach, Old Harbor, South Marina, and Downtown and Maritime Museum areas for the virtual realm.



Radio Frequency Identification (RFID): Dr. Bradley Bazuin and the RFID Laboratory is collaborating with Dr. Margaret Joyce and a large team of faculty, post-docs and students from the Paper Engineering, Chemical Engineering, and Imaging (PCI) department on a state of Michigan the 21st Century Jobs Fund initiative award of $966,000. Titled Printed RFID Tags on Packaging Materials, the research involves the design, development and testing of printed RFID antennas and RFID Tags directly on various printed substrates using a range of inks, substrates and printing processes. During the first year, this work primarily focused on printed conductors and antennas. This year's tasks involve the printing of active transistors and components with characterization of device and material performance.

Activities to support this work include: purchase and construction of an antenna testing range in the RF/RFID Lab to measure reference and printed antenna gains and 3-dimensional patterns , purchase of DC and 1 kHz AC micro-ohm impedance meters to measure characteristic of printed conducting lines, purchase of a mega-ohm impedance meter to characterize substrate resistivity and measure printed dielectric and semiconductor properties, the set-up of available test equipment to perform resistor and transistor low-frequency I-V characteristics, and the design and implementation of an RF test fixture for RF I-V curve measurements.

For more information on the RFID Laboratory and RFID technology, see Dr. Bazuin's WMU RFID Lab web site at: http://homepages.wmich.edu/~bazuinb/RFID_Lab.htm. (Brad Bazuin)

Chaotic Clock Dithering to Reduce Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI): Dr. Bazuin has been working with a graduate student, Ryan Milke, and funding from a NASA MSGC Seed grant to refine work initially performed in 2006-2007 as a senior project by Andrew Cochran, Richard Courtade, and Daniel Mulkey. This work entails exhaustive testing of the PC board that had been fabricated, prototype development of reduced voltage and higher frequency oscillators, and the construction of a second generation PC board. Preliminary testing has demonstrated a reduction of greater than 10 dB in the peak spectral output of a reference oscillator.

ECE supporting Sunseeker 2008 CAN (Controller Area Network) Bus Developments. Two senior project teams are working on electronic modules that are designed to connect to the Sunseeker solar car CAN network. One project, consisting of Steven Ballard, Stephen Beerbower, Michael Lowary, and Andre Williams, is developing a wireless telemetry and USB memory data logging subsystem that will monitor CAN traffic, collect important data packets, store data on a USB memory stick if desired, and wirelessly send performance information to the chase vehicle to

provide status and to support on-course race planning. The second project, with the team of Mark Jochum, Michael McCabe, Aaron Rose, and Russell Schoenbeck, is developing a CAN network module to collect driver braking, turn-signal, and emergency flasher indicative packets and then drive lower power LED turn-blinkers, brake-lights, and emergency flashers. This should significantly reduce power consumption in the devices while integrating the operation with the CAN network. Drs. Liang Dong and Bradley Bazuin are supporting these projects with sponsorship from the Sunseeker team directed by Abraham Poot (MAE) and Dr. John Kapenga (CS).
Electronic Network and Real-Time Vehicle Simulation Test Bed Developments: Three members of the department are collaborating with a multidisciplinary team to seek funding for two vehicle system related test beds: a CAN electronic network test bed modeled on the Sunseeker 2008 CAN network and a table-top sized real-time Selective Fidelity Vehicle Simulator Test Bed. The multidisciplinary team, consisting of John Kapenga (CS), Richard Hathaway (MAE), Claudia Fajardo (MAE), Mitchel Keil (IME), Janos Grantner (ECE), Liang Dong (ECE), and Bradley J. Bazuin (ECE), has submitted an initial capital equipment gift proposal. These test beds can provide tremendous opportunities for student demonstrations, course laboratory assignments, independent research projects, and industrial collaboration.

Retention and Recruitment Initiatives – With the focus remaining on recruitment and retention the ECE Faculty have been busy preparing and hosting a variety of events.

Society of Women Engineers (SWE) engineers hosted a Girl Scout workshop featuring future careers and fun. Lauren Stefl and Megan Harris, both nine-year-old fourth-graders from Plainwell Troop 126, also pondered what becoming an engineer means. "Engineering looks really interesting," Stefl said, "But it also looks like it is a lot more work than we have to do right now at school."

Even if the scouts don't become engineers, the workshop opened a dialogue, Miller said. Her daughter, Michelle Miller, has indicated interest in careers as a veterinarian and as an engineer, but Miller isn't concerned about what her daughter finally chooses. "The important thing is that she's thinking about it," Miller said. "One of the biggest things about this workshop is that the girls have this experience, and now we can talk about college with them." Dr. Ikhlas Abdel-Qader, of the ECE Department is the Faculty Advisor for SWE.

Vijay Meganathan, an electrical engineering student in WMU's master's program, discusses electrical circuitry with fourth-graders **Sydney Landon** (center), 9, Plainwell Troop 126, and **Fiona Beaton** (right), 10, Portage Troop 368.

Freshmen Orientation – In the summer of 2007 ECE held approximately 14 freshmen orientations. The orientations were set up with an overnight stay. On the first day they visited the main campus and a mixer was held for the parents and faculty. The next morning the students were brought to the engineering campus and the ECE students were greeted by ECE Student Ambassadors, upper level ECE students who provided tours of our campus and help guide the future freshmen from one area to the next as they registered for their fall courses. The ambassadors talked to the future students about their experiences here in the ECE Department and about the outside activities available. The ECE Faculty provided one on one advising with the students and staff helped the students register for their courses.

The ECE Department held two Meet & Greets this year one in each semester. They were scheduled around the beginning ECE courses ECE 2500 and ECE 2510 to encourage attendance of the ECE students. A continental breakfast was provided approximately 90 students attended giving the faculty and staff the opportunity to visit and meet the students.

ECE students at the Fall 2007 Meet & Greet

Tours – throughout the academic year have been provided to various groups of students. The ECE faculty have often provided lab experiences for the visiting students and are available to meet with the students and their families to answer questions about the programs and curriculum. The ECE faculty has provided many different formats and labs for the visitors.

Many CEAS faculty, administrators, students, and emeriti supervised events and contributed to the success of the Region 10 Science Olympiad, held Mar. 15 at WMU. About 400 area middle school and high school students competed in team activities that focused on science concepts, processes, and applications and technology. Scot Conant, CEAS student outreach and recruitment coordinator, coordinated the WMU event. Drs. Frank Severance and Liang Dong developed and oversaw the Circuit Competition approximately 30 high school students participated in this event.

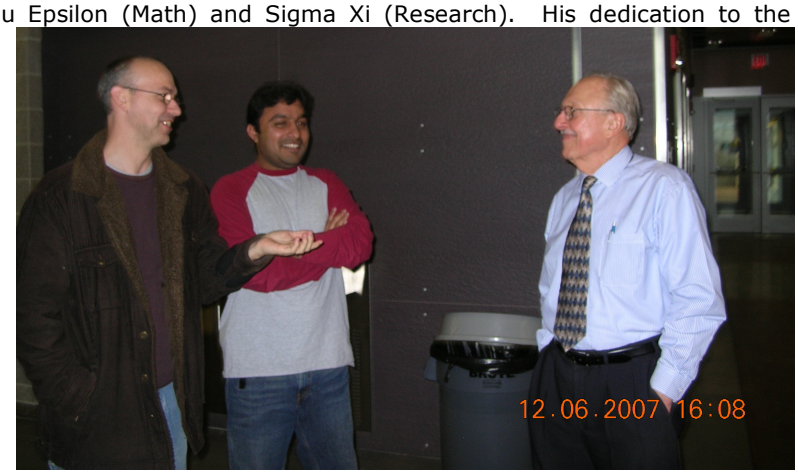
Highlights of Recruiting and Retention Activities
07/08

9-20-07	Major Excitement – open house held on main campus, represented our programs.
9-21-08	Administrative and Faculty tour for Lake Michigan College and held a discussion on a 2 + 2 plan.
9-27-08	Engineering Opportunity Day, day long job fair.
10/5-6/07	A WMU Family Weekend & CEAS Family Preview Day held on October 5-6 prepare and oversee a Classes without Quizzes component, provide labs and tours.
10/6/07	WMU Graduate Student Open House
10/11/07	Tau Beta Pi recruitment in Detroit for Graduate Program
10/12/07	Reception for all Graduate Students in Engineering
10/19/07	CEAS Open House with Hands on Labs
11/2/07	CEAS Open House with Hands on Labs
11/6/07	ECE Meet & Greet
11/14/07	Two Presentations at KVCC about CEAS programs
11/15/07	Lunch meeting with Glen Oaks, LMC, KVCC faculty at Parkview Campus.
11/30/07	CEAS Open House with Hands on Labs
1/26/08	Medallion Scholarship Competition, Judges, and labs tours.
2/8/08	Community College Administrators and Faculty lunch and tour of labs.
2/13/08	IEEE Professor for a Day
2/26/08	ECE Meet & Greet
3/15/08	Region 10 Science Olympiad, prepare circuits test, oversee and score.
3/20/08	KAMSC hands-on labs and workshops
3/21/08	KAMCS hands-on labs and workshops
June 08	Freshman Orientation.

On Wednesday, February 20th the IEEE student branch hosted an alumni Professor for the Day. This event was schedule to enhance the Engineering Week celebration with that dinner being held on Tuesday night. Invitations were sent out to several alumni to join us the next day and work with an ECE faculty to teach a segment of the class. At lunch they joined the IEEE Student Chapter for their weekly meeting. Each alumni received a framed photo of themselves lecturing in the class. Photos were taken by Laura Decker and a WMU frame was provided by the alumni office. This was the first time this event was held and we look forward to it expanding. Pictured is Karan Kohli, a Product Engineer for Dana Corporation, who participated in the event.

Professor Joseph A. Kelemen retired from the Electrical and Computer Engineering Department this past December. Joe started his career in industry working on the design of motors and alternators. His passion for teaching began forty-seven years ago when he was invited to teach electric machines at St. Louis University. Then, six years later he joined what now is the Electrical and Computer Engineering Department here at Western Michigan University. In the late sixties Joe and his family traveled on WMU's behalf to teach in Nigeria for two years. He feels this was an educational experience which has lasted for a lifetime as it was intellectually and culturally stimulating, challenging, and most rewarding to his whole family. Joe's legacy for the Electrical and Computer Engineering Department is the standard of excellence he developed and consistently practiced in his teaching in both the classroom and in the laboratory. It will be strange to walk the Parkview Campus and not see Joe working side by side with students.

His outstanding teaching and research won him the three National Science Foundation Scholar awards and the Schmidt Scholar. His is a member of the honor societies Etta Kappa Nu (Electrical Engineering), Pi Mu Epsilon (Math) and Sigma Xi (Research). His dedication to the students, department and university will be missed.



Joe and Marcellus plan to spend some time traveling to visit family and friends. He also plans to continue his gardening and to develop another passion, oil painting, by taking classes at the Kalamazoo Institute of the Arts. The department combine the Holiday Social and his retirement party on December 6th during the noon hour here at the Parkview Campus.