Radio Frequency Identification (RFID): Dean Michael Atkins committed CEAS Dean’s office funding to support the establishment of an RFID Research and Development Laboratory in June 2004. This commitment was based on a series of meetings and discussions with Southwestern Michigan industry and CEAS faculty during the Fall 2003 and Spring 2004 semester.

The RFID Laboratory is hosted by the ECE Department, with Dr. Bradley Bazuin as the principal investigator. Goals of the laboratory are to:
1. provide an RFID resource center offering system engineering support and services for Southwestern Michigan;
2. provide technical and theoretical training for RFID users, implementers, and developers;
3. define and develop RFID system solutions for non-mainstream, challenging environments and implementations, and
4. research critical technology to improve the accuracy, reliability, and performance of RFID systems toward the goal of achieving 100 percent reading of RFID tags for all perishable and non-perishable products.

Dr. Bazuin has made numerous presentations on RFID, provided multiple demonstrations of the technology, hosted a number laboratory tours for those interested, has developed and supported both field trials and various laboratory testing, and is expecting multiple funded field trials and support activities to occur in the coming months.

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)

Integrated Smart Wireless SAW Sensors and Systems: In many applications, sensors and data collection processing must be distributed and placed in inhospitable or inaccessible environments. This complicates sensor and system design by requiring devices with small size, rugged construction, efficient power supply for active components, communications for derived information, and simple installation with a minimum amount of infrastructure and overhead. In this project we are developing integrated smart wireless surface acoustic wave (SAW) sensors and systems composed of distributed wireless SAW sensors, sensor communication transceivers, and a centralized host. New generations of SAW microsensors provide measurements of a wide range of physical and chemical parameters, including: temperature, pressure, chemical concentration, gas concentrations, etc. Compatible with integrated circuit-processing techniques, SAW devices can and will be combined with active ASIC circuitry into integrated smart SAW sensors (Massood Atashbar collaborating with Professor Brad Bazuin).

Early Detection of Prostate Cancer: In the project we are developing the novel concept of Flexural Plate Wave (FPW) acoustic sensors. According to the American Cancer Society Facts and Figures, there would be an estimated 220,000 new cases of prostate cancer (CaP) in the year 2003 with around 28,000 men succumbing to the disease. Two assays will be performed simultaneously. One assay will use a monoclonal antibody that recognizes both fPSA and PSA-ACT (Mab PSA399) to determine the concentration of tPSA. The other assay, which will measure fPSA, will use Mab PSB999, which recognizes an epitope present on fPSA but masked on PSA-ACT. The binding of antigen to the immobilized antibodies will alter the mass of the sensor membrane thus causing a drop in the wave velocity, which is correlated to the resonance frequency of the device. FPW will have distinct advantages over previously established assays, as it will allow...
for increased sensitivity to reliably detect very low concentrations of PSA-ACT. Furthermore, a FPW device will also be cheaper to operate, allow for the development of a small hand held device and not use radioactivity. ELISA kits used to detect PSA require separate steps, each with separate reagents. Each ELISA analysis requires a separate distinct reaction and, in addition, requires a label for detection of the analyte. Our proposed method needs no label or distinct reagents and is therefore, much easy and simpler to implement (Massood Atashbar collaborating with Professor Bruce Bejcek for Biology department and Dr. Hardin, West Michigan Cancer Center).

**Steam Trap Acoustic/Ultrasonic Analysis:** Dr. Massood Atashbar and Dr. Bradley Bazuin, with significant contributions from their graduate student, Mr. Shakil Housain, have been collaborating with Armstrong International in Three Rivers, MI in the areas of sensor measurements, sensor data processing, and prototype system development. The tasks has progressed through four phases of investigation and development, starting with fundamental data collection using laboratory grade equipment and advanced signal processing techniques for information identification and extraction. The initial sensor data measurements and analysis lead to preliminary sensor and measurement system definition, design and breadboarding during phases 2 and 3. The fourth phase of the project has supported Armstrong International’s prototype product development and testing. As this product is in the field test stage and has not been released and due to proprietary nature of the information no further comments can be made at this time.

**Micromachined Wireless Dosimeters for In-Situ Radiation Measurement.** In this project we are developing wireless dosimeters for in-situ radiation measurements. These dosimeters can be used to monitor the delivered radiation to the patients going through radiation therapy for cancer treatment. We are developing both ex-vivo (outside the body) and implantable systems and are also targeting applications such as nuclear smuggling and environmental monitoring. (Massood Atashbar collaborating with Purdue University, Professor Babak Ziaie).

**Nanowires and Nanoparticles Microsensors:** In this project we have synthesized and fabricated parallel arrays of Palladium nanowires using nanotemplate manufacturing approach for hydrogen gas detection. These sensors also can have applications in Auto Industry, and Fuel cell systems. These sensors can be modified for detection of chemical warfare agents for applications of homeland security. We have studied the morphology of the deposited nanoparticles using an Atomic Force Microscope (AFM) in non-contact mode. (Massood Atashbar)

**Mechanical and electrical characterization of b-Ga2O3 nanostructures for sensing applications:** Using a chemical vapour deposition method single crystalline b-Ga203 were prepared at 700°C. Their structural and microstructural properties have been studied by means of X-ray powder diffraction (XRD), field emission scanning electron microscopy (FE-SEM), energy-dispersive x-ray spectroscopy (EDS), high-resolution transmission electron microscopy (HRTEM), and selected-area electron diffraction (SAED). Mechanical property measurement of individual nanostructures was measured through parametrically driven cantilevered resonator. I-V electrical properties of these nanowires and nanoribbons b-Ga203 were also investigated. Concepts of using nanowires and nanoribbons as highly sensitive chemical and biochemical sensors are introduced (Massood Atashbar collaborating with University of Illinois Urbana-Champaign, Professor Min-Fen Yu).

**Magnetic Nanowires and Nanoparticle:** In this project we have synthesized and fabricated nickel nanodots and arrays nanowires using nanotemplate manufacturing. Magnetically manipulated nickel nanoparticles and nanowires have also been prepared which have the potential to revolutionize current data storage technologies and cell recognition. We have studied the morphology of the deposited nanoparticles using an Atomic Force Microscope (AFM) in non-contact mode (Massood Atashbar collaborating with Professor Valery Bliznyuk).

**Intelligent Decision Support System for Eye-Hand Coordination Assessment:** The objective of this project is to develop an automated assessment and training procedure for children with eye-hand coordination problems that may finally lead to improvement in handwriting. The system under development is expected to reduce the burden and the cost factor of having a trained professional at assessment or training sessions. The Intelligent Decision Support System (IDSS)
will be based upon a fuzzy automaton. By using qualitative (fuzzified) data from the previous test the system will make a
decision on the complexity of the next test to be performed. A testbed that is made up of a six-degree-of-freedom force-
reflecting haptic interface device called PHANToM, the accompanying GHOST SDK Software and IDSS software will be
developed to conduct experiments. (Janos Grantner and Norale Pernaleti, in collaboration with Sandra Edwards, of the
Department of Occupational Therapy)

**Generic Encapsulated Fuzzy Automaton Software Agent:** The objective of this project is to test the software module
(GEFASA V1.0) using real-time data. The GEFASA V1.0 software module has been developed and is being tested using
dummy input data. According to the plans, the Intelligent Fuzzy Controllers Lab in the ECE Department will be
connected through the Internet to an ABB R & D lab in Sweden. The ABB Lab will pass real plant data collected from a
cold rolling mill to the GEFASA V1.0 and then the output of the current controllers for the plant will be compared with
the output data produced by the GEFASA V1.0. This software module will be fine-tuned to be considered as a new tool to
recover a supervisory control system from Ontological De-synchronization problems. (Janos Grantner and George Fodor,
of ABB)

**Small Business Innovative Research:** The purpose of this project is to introduce, apply and evaluate available new and
emerging Web3D Internet technologies to help bolster on and off-season tourism for lakeshore West Michigan
communities through a process called 3D virtual tourism (3DVT). 3DVT allows the natural heritage, cultural, recreational
and commercial features of a tourist community to be represented in a virtual 3D environment on the Internet.3DVT also
incorporates appropriate tourism schema from tourism content curators and experts to help implement tourism
management strategies. The economic return of this system will be derived from the increased tourism and e-commerce
spawned by the virtual tourism feature, which is the hypothesis of the research. During the Phase I research, the
feasability of the approach will be examined through focus group studies of a simple 3DVT model and process to be
designed for West Michigan lakeshore community South Haven. (Dean Johnson)

**Design of a Reconfigurable State Transition Algorithm for Fuzzy Automata:** The aim of this project is to design a
hardware implementation of the state transition algorithm for the Hybrid Fuzzy-Boolean Finite State Machine (HFB-
FSM) model. An application area for the HFB-FSM is automatic fault detection and identification and recovery from
faults in complex industrial control systems. This project is part of a broader research effort to develop a hardware
accelerator for a reconfigurable HFB-FSM and to investigate different reconfigurable hardware algorithms and
architectures. (Janos Grantner)

**Wireless Systems and Networks:** The establishment of the Laboratory for Wireless Systems and Networks in its early
stages is supported by the equipment grants from Xilinx, Inc. and National Instrument, Inc. Currently, the research efforts
focus on:

- **MIMO-OFDM Wireless Communications** – This project analyzes the impact of time varying channels (time
variation could arise from Doppler effects or frequency offsets) to the multiple-input multiple-output (MIMO)
orthogonal frequency division multiplexing (OFDM) wireless communications systems. Linear filters are
designed for the inter-carrier-interference mitigation, and they are modified effectively in the context of space-
time block-coded transmissions. (Liang Dong)

- **Ultra-Wideband Radio for Wireless Personal Area Networks** – The applications of ultra-wideband (UWB) radio
in wireless personal area networks (WPAN) are impeded by the drastic transmitted power limitations imposed by
regulation authorities. This project uses multiple-antenna transceiver at the terminal device and collaborative
nodes in a WPAN to enhance the link quality and facilitate synchronization of UWB systems. (Liang Dong)

- **Integration of Heterogeneous Wireless Networks** – Various wireless communications systems will coexist and
interwork in the future, and seamless integration of these heterogeneous wireless systems will be important. This
project explores on open architecture based on the public IP network to integrate heterogeneous wireless systems.
The open architecture consists of a public IP network, an authentication/ authorization/ accounting server, a home
agent, and radio access points. (Liang Dong)

**Nonlinear Circuits and Systems:** In collaboration with Dr. Bazuin (WMU), Dr. Giuseppe Grassi (University of Lecce,
Italy), and undergraduate students, Dr. Miller continues to explore implementations and applications of chaotic systems in
areas including data encryption and communications. (Damon Miller)
Computational Intelligence: In collaboration with Dr. Garry Greenwood (Portland State University), Dr. Miller and Mr. Rodrigo Arguello (Master's student) are investigating using evolutionary computing techniques to "evolve" efficient artificial neural network structures. The plan is to eventually utilize a resident Linux-based Beowulf supercomputer developed under the direction of Dr. Bazuin to conduct this computationally intensive work. (Damon Miller)

Engineering Education: An NSF sponsored grant (Miller, Atashbar, Severance, Tanner) to develop ECE 123 Mobile Robotics: An Introduction to Electrical and Computer Engineering just wrapped up. The final report will be available from http://homepages.wmich.edu/~miller. (Damon Miller)


Digital Information and Image Processes: The ITIA center is supported by National Science Foundation to foster interdisciplinary collaboration in the area of digital information and image processing/analysis. Currently, this center houses different research stations equipped with advanced imaging and computing hardware and software to allow research and education in this rapidly growing field of technology. Some of these are:

- One specific workstation is the microscope station. This tool is being utilized by the electrical engineering students for research projects in tele-pathology applications, and in image capture and compression. The objective of these projects is to capture, compress, and transmit in real time pathology pictures for experts anywhere else in the world. Another utilization of this state-of-the-art microscope is by graduate students in the Paper and Printing Engineering and Science Department who are using it for research in printing quality control.
- Real Time Image processing stations using Texas Instrument TMS6711. That is used for real time image capturing, analysis and transmission. Current projects include real time edge detection algorithms for applications such as industrial inspection and security.
- Other stations being purchased but not yet delivered are three imaging systems: sonar, infrared, and radar systems for nondestructive applications. This is in collaboration with faculty from the Civil and Construction engineering department.
- A wireless sensors workstation is currently being acquired for driver monitoring system. This includes of a wide array of sensors to monitor internal and external conditions of the car and driver. This project is in collaboration with Dr. Gupta from Computer science. (Ikhlas Abdel-Qader)

Internet 2: “High Speed Wavelet-Based Compression and Transmission of Mammograms over Internet2,” Office of Information Technology, Western Michigan University, June 2003-December 2004. This project is in collaboration with Dr. Bruce from Mississippi State University. (Ikhlas Abdel-Qader)

Interdisciplinary Research with the Occupational Therapy Department: Collaborations with Professor Sandra Edwards in the application of the use of robotics for assessment and therapy of children with eye-hand coordination and hand-manipulation problems. The research team coordinated by Pernalete and Edwards consists of Electrical Engineering and Occupational Therapy students.

Children with these types of disabilities are diagnosed and treated at the Unified Clinics at WMU. Eye-hand coordination problems are generally reflected in difficulties with handwriting, space-orientation and daily activities such as dressing, washing etc.

The team administers a set of assessment paper-based tests commonly used by occupational therapists before and after the robotic therapy. The robotic therapy consists of executing tests by following various patterns that have been developed in the virtual environment. The robotic device has a haptic capability, which allows the user to feel ('touch') the objects developed in the virtual environment.

The results so far of this on-going research have demonstrated considerable improvements in the handwriting scores for the tests administered. These results have been published in the IEEE Int. Conf. on Robotics and Automation (ICRA) and the IEEE Int. Conf. on Rehabilitation Robotics. (Norali Pernalete)