EECS News

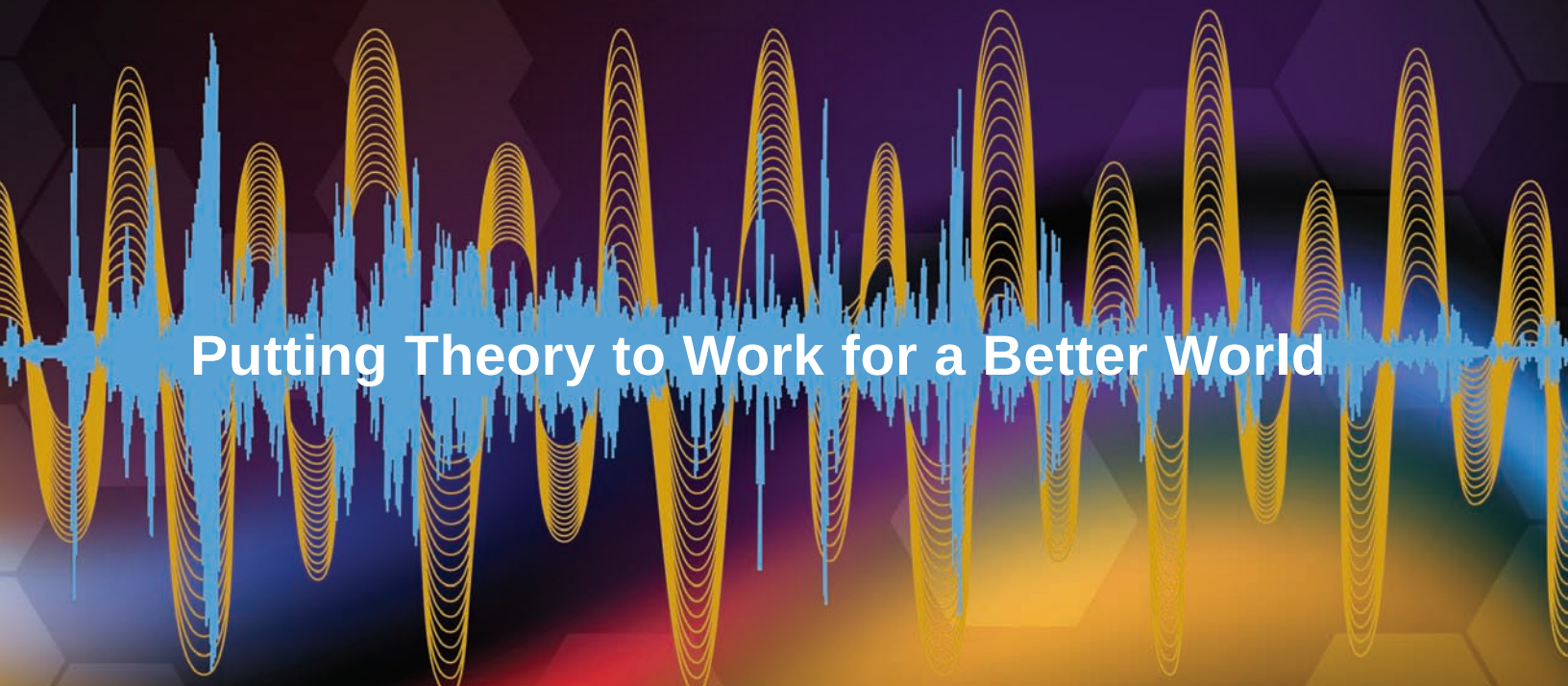
Department of Electrical Engineering and Computer Science

When Democracy and Technology Collide

UNIVERSITY OF MICHIGAN

2012

Signal Processing @ Michigan



Putting Theory to Work for a Better World

In This Issue

Electrical Engineering and Computer Science

1301 Beal Avenue / 2260 Hayward Street
Ann Arbor, Michigan 48109-2122
PH 734 764-2390
FX 734 763-1503
www.eecs.umich.edu

EDITORS:
Catharine June, Communications, ECE
Steven Crang, Communications, CSE

GRAPHIC DESIGNER:
Rose Anderson, EECS

PHOTOGRAPHERS:
Doug Coombe, Steven Crang, Catharine June, Laura Rudich, Scott Soderberg, Marcin Szczepanski, Joseph Xu

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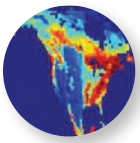














Welcome to EECS News 2012

Khalil Najafi, Chair
Electrical and Computer Engineering Division

Marios Papaefthymiou, Chair
Computer Science and Engineering Division

Welcome to the 2012 edition of the University of Michigan *EECS News*. In this publication, you'll find a variety of stories that illustrate how EECS faculty, students, and alumni have made huge strides as researchers, collaborators, team members, entrepreneurs, mentors, and leaders over the past year. We find the breadth of these achievements to be astounding!

Research in this Department ranges from highly theoretical to strongly lab-based, and is inspired by the current and future concerns facing society. Our first featured research story reveals the broad range of explorations taking place in signal processing and the real-life impact associated with that work. Michigan researchers in this field build on existing and new theory to push the boundaries of what can be done. From medical imaging, audio applications, and nuclear non-proliferation to big data applications in medicine, social media and finance – signal processing plays a critical and often surprising role in our lives.

Our second featured research activity takes place at the intersection of computing and democratic practices. Prof. J. Alex Halderman's research has demonstrated that the conveniences of Internet voting and electronic vote-counting machines unfortunately represent a potential threat to democracies worldwide. His work includes exposés of the security shortcomings found in current e-voting technology, as well as proposals for the proper place of technology in elections and its applicability to the spread of democracy to regions now locked behind the iron curtain of Internet censorship.

We are delighted to announce the establishment of the NSF Center for Photonic and Multiscale Nanomaterials (C-PHOM). Prof. Ted Norris, Director of the Center, brings his broad interdisciplinary experience to this exciting area of investigation that aims to develop novel materials to manipulate light in new ways. In other areas, EECS researchers are making communications devices for use in developing regions. They are building computer electronics that better mimic the complex functioning of biological brains, and divining economic conditions through online data mining. They are making sure alternative energy reaches the nation's grid. You'll find these stories and many others in the Research Briefs section beginning on p. 14.

If you'd like to get a feel for the many activities going on in the department, you'll find several beginning on p. 26. Among our most important activities is the hiring of new faculty, and we are thrilled to welcome Laura Balzano, Kevin Fu, Emily Mower Provost, Shai Revzen, and Grant Schoenebeck to our team.

In the realm of technology transfer, EECS faculty and students continue to develop and commercialize cutting-edge research. Kang Shin, the Kevin and Nancy O'Connor Professor of Computer Science, has developed technology to increase the efficiency of battery-powered systems and vehicles. CSE Chair and Professor Marios Papaefthymiou's venture, Cyclos Semiconductor, has developed energy efficiency technology for portable computers that has been adopted by AMD, and student venture ASK Interfaces has developed a means for individuals with fine motor control disabilities to communicate electronically via tablet device. You'll find more on pp. 40-41.

In this newsletter, we pause to celebrate the accomplishments of Kensall D. Wise, the William G. Dow Distinguished University Professor Emeritus of Electrical Engineering and Computer Science. Since coming to Michigan in 1974, Prof. Wise has built a world-class program in MicroElectroMechanical Systems (MEMS) and microsystems that is supported by one of the top nanofabrication facilities in the nation. You can read more about his remarkable tenure at Michigan on pp. 42-49.

Our students continue to amaze us. Two new student groups, MSuite Collaborative and Michigan Hackers, have formed to develop mobile apps and to support experimentation with technology. Prof. Heath Hofmann is advising the new interdisciplinary team called Michigan Hybrid Racing, where students build and race electric and hybrid electric vehicles. In addition, many existing interdisciplinary teams sponsored by the department have won or placed highly in recent competitions, thanks to the key contributions of our students. This includes U::M Autonomy, the Solar Car team, Michigan Autonomous Aerial Vehicles, Michigan Hybrid Racing, and the Mars Rover team. For more about our students, see pp. 50-56.

Our alumni, nearing 20,000 strong, continue to make us very proud! We've highlighted four of them in this issue: Tom Conrad of Pandora, Sid Meier of Firaxis Games, W. David Tarver of Spirent, and Richard P. Wallace of KLA-Tencor Corporation. In addition, we have shined the spotlight on alumnus Ernest S. Kuh, William S. Floyd, Jr. Professor Emeritus at Berkeley, and U-M alumnus J. Robert Beyster, both of whom have established important programs benefiting the Department and its students through their generous endowments.

We hope you enjoy this snapshot of what's been happening in EECS since last year. Please stay in touch. Together we can continue to do great things!

Signal Processing

Theory
Algorithms
Mathematics

Tools

Optimization
Computer Vision
Random Matrix Theory
Compressive Sampling
Computational Imaging
Source Coding + Compression
Statistical Estimation + Learning
Machine Learning

Collaborators

Biologists
Statisticians
Pathologists
Oncologists
Radiologists
Geneticists
Psychologists
Mathematicians
Neuroscientists
Environmental Scientist
All Engineeering Disciplines
Computer Scientists
Musicians

At Work in the World

Environmental Monitoring

Security

Networking

Medical Imaging & Diagnostics

Personalized Medicine

Construction Site Monitoring

Sound Technology

Big Data

Nuclear Nonproliferation

Image Indexing

Assistive Technology

Assisted Driving

Music, Image & Video Transmission

Signal Processing @ Michigan:
Putting Theory to Work for a Better World

What's That Signal?

In the movie *Independence Day*, David Levinson's algorithm detects an unexpected signal buried in atmospheric background noise. When he decodes the meaning embedded in the signal, he realizes that the world is about to be attacked by aliens. Had the original signal not been detected, it definitely would *not* have been a day of independence.

Similarly, though perhaps with less dramatic consequences, signal processing researchers at Michigan are on the lookout for ways to detect and manipulate signals that will help make the world safer (assisted driving, nuclear material detection, surveillance); healthier (medical imaging and diagnosis, environmental monitoring); and more enjoyable (audio, image, and video processing)

Signal processing is the art of generating, transforming, and interpreting information, which we think of as being a signal. Some signals can be detected electronically, while others might be a pattern that arises from data such as a gene pool, social media activity, or economic data. Signal processing delves into nearly as many application areas as can be conceived.

Tools and Collaborations

Michigan faculty bring a variety of theoretical tools to the task of detecting and manipulating signals. These tools include machine learning, random matrix theory, computer vision, compressive sampling, computational imaging, source coding compression, optimization, and statistical estimation & learning.

With the explosion of information available in today's world thanks to pervasive sensing, access to the nanoworld, and increased computational and storage capability of computers, signal processing faculty are approached by potential collaborators from all areas of science and engineering.

"This is not a group that acts in isolation," said Al Hero, R. Jamison and Betty Williams Professor of Engineering, also director of the signal processing area and professor of biomedical engineering and statistics. "The high level of interdisciplinary and cross-disciplinary interactions defines our approach to signal processing."

Michigan signal processing faculty collaborate with radiologists, pathologists, oncologists, geneticists, biologists, statisticians, mathematicians, physicists, and materials scientists, just to name a few. The fact that top researchers in many fields can be found right here at Michigan greatly facilitates their work, yet they still reach out and actively collaborate with others in academia and industry across the country and around the world.

The Theory Behind the Work

Michigan signal processing faculty approach their research with an eye to fundamental theory so their work can be applied to an ever-expanding array of problems. If a project comes along that tests the limits of what can currently be done, they become intrigued. If it seems to require new theory – they get excited.

"While we may solve a specific problem related to economic forecasting or networking," stated Prof. Hero, "this same research can be extended to gaining environmental insights from tree-rings, or earthquake activity."

The theory is highly mathematical. Researchers are trying to extract the maximum possible information from the available data using algorithms and mathematical modeling. An algorithm can be thought of as a computer program that takes the data, in this case a signal, and outputs some kind of decision that will yield the desired information.

Some of the applications to which Michigan faculty are applying their theory are described below.

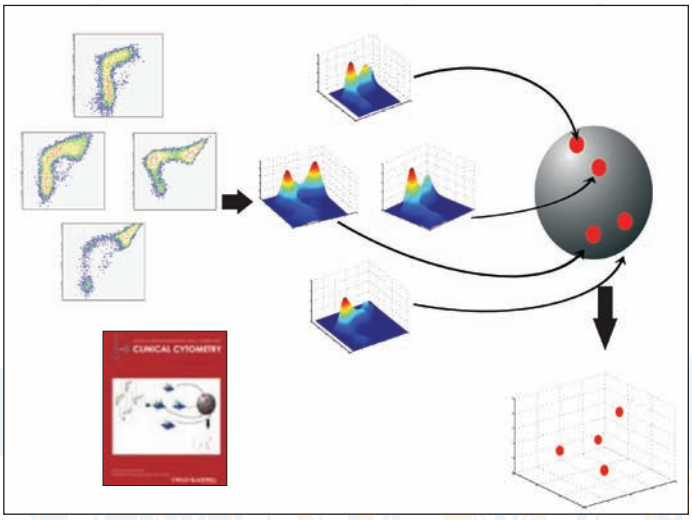
Flow Cytometry for Diagnosis of Blood-related Illness

Flow cytometry is the process of gathering and quantifying properties of individual blood cells. It is used by hemato-pathologists to diagnose blood-related disorders such as leukemia and lymphoma.

Part of the analysis involves isolating the cells of interest manually. The key challenge lies in the fact that each individual's blood has unique biological markers which must be identified and classified, a process that is currently done by hand. Prof. Clay Scott is applying machine learning techniques to automate this process, saving time and eliminating some forms of human error. He is working with a pathologist in the U-M Medical School who has provided him with blood samples so that he can test his new computational theory.

In related work, Prof. Hero was able to render clinical flow cytometry data more interpretable to pathologists through a method called Fisher Information Non-parametric Embedding (FINE). Clinical flow cytometry can reveal up to 12 different properties of a given cell, and about 100,000 individual cells are analyzed for each patient. The pathologist needs to look at all the resulting data and determine what it means. The FINE method, which is currently being used at U-M Hospital, applies a computer algorithm to the data and pulls out the most relevant information needed to determine prognosis of a disease.

More recently, Prof. Hero successfully applied FINE and a novel visualization method called Information Preserving Components Analysis (IPCA) to the problem of diagnosing myelodysplastic



Prof. Hero's research was featured on the cover of Cytometry Part B: Clinical Cytometry, vol. 80B, Issue 5, Sept. 2011. The figure show a schematic overview of FINE.

syndromes (MDS). MDS are a group of diseases of the blood and bone marrow that can lead to anemia or even leukemia.

Flow cytometry data comes in the form of a distribution of the properties of tens of thousands of a patient's blood cells. Under a recent grant from NSF, Al Hero and Clay Scott are teaming up to develop new methods for estimation and classification of distributional data, which will be applied to flow cytometry. They will collaborate with Dr. Lloyd Stoolman at the U-M Medical School.

Predictive Medicine is Big Data

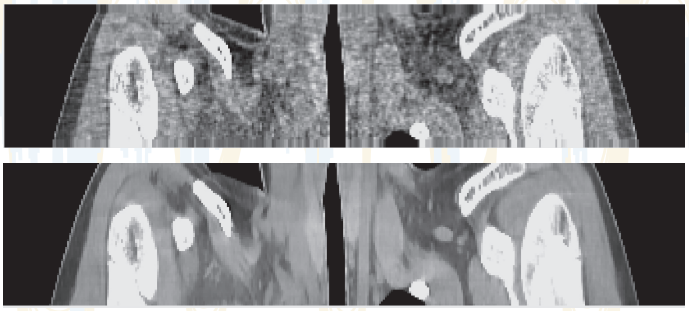
Access to information in today's world is seemingly unlimited. Data coming in from sensors and other information gathering devices now includes the nanoworld, and modern computers seem capable of storing it all. This access to "big data" enables cutting-edge research to be done in areas such as genomics and predictive medicine. It is also pushing researchers to allocate resources at each step so they can sift through the available data.

Prof. Hero is investigating individual gene expressions to determine an individual's relative health as well as their susceptibility to different behavior patterns, such as fatigue or stress. "The idea is you want to take gene sequence data from each individual," explained Hero, "and compare it to their gene expression at a later date to detect changes, or to predict illness." However, the amount of genetic information is so vast it has to be considered sequentially, and much of the information isn't even reliable. His goal is to expend as few resources as possible to get usable baselines for comparison.

Predicting who will get the flu also requires accessing big data sets. Collaborating with faculty from various fields and institutions, Prof. Hero is having success unraveling what in our complex genomic data accounts for why some get sick while others don't. He studied 22,000 genes in 267 blood samples, the largest sampling pool of its kind ever investigated. To find the meaningful data signal amidst the noise, he adapted a pattern recognition algorithm previously developed for satellite imaging of the environment. The algorithm was able to identify the unique genomic signatures associated with immune response and flu symptoms.

Better, Faster Images With Lower X-ray Doses

One of the key ways doctors detect abnormalities in the human body is to take an image through an MRI, CT scan, or other method. These images also track the progress of medical treatment. Prof. Jeff Fessler has spent much of his career improving the quality of images received through these imaging



Traditional CT scan vs. improved image using 25% of the X-ray radiation.

techniques, which allows for a reduction in the amount of X-ray some of these machines put into the body. He accomplishes this by employing complex algorithms. He was involved in the early stages of technology known as Veo, manufactured by General Electric, that is currently in use at the University of Michigan Health System. Veo creates quality CT scans using much lower doses of radiation than was previously needed.

With radiation levels now at a minimum, his attention has turned to getting even better images, including 3D images, from the raw data that comes out of a CT or MRI scanner, and getting them faster. He is currently working with computer science colleagues at Michigan to significantly speed up the processing time.

Imaging With Motion

CT scanners are often used to generate 3D photos of coronary arteries, but the fact that the heart keeps beating disturbs the resulting image. CT and other types of medical scans don't operate like cameras which can employ fast shutter speeds and generate instant photos. Instead, signal processing engineers design specialized algorithms that turn the raw data generated by the medical devices into images that can be interpreted by humans, and CT scanners can't get that much faster. MRI scans are even slower.

Prof. Fessler is working with doctors in Radiation/Oncology to generate 3D MRI images of tumors while taking into account motion caused by a patient's breathing. This is called 4D MRI. "One of the holy grail problems that my students and I are tackling is motion in medical imaging," he said.

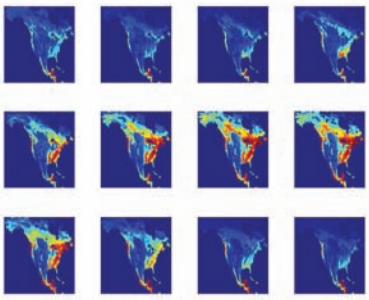
Tracking Breast Cancer Treatment

Comparing two different medical images of the same area, called image registration, is often necessary to track the progress of a disease and the success of a given treatment. However, these images can't easily be compared when taken at different times, or with differing methods, and they typically

don't come with any kind of confidence statement as to the accuracy of their alignment. Professors Fessler, Hero, and Scott are working on this issue as part of a major effort headed by Dr. Charles Meyer, Director of the U-M Radiology Digital Image Processing Laboratory. One of the key applications of the research is to track the progress of breast cancer in an individual.

Nuclear Nonproliferation to Environmental Monitoring

Outside the medical field, Prof. Scott is collaborating with Prof. Sara Pozzi of Nuclear Engineering and Radiological Sciences on a project that has the ultimate goal of nuclear nonproliferation. Their research would enable detection of nuclear material at ports of entry. Prof. Pozzi's group uses an inexpensive detector that reacts mainly with neutrons and gamma rays. Scott is helping to classify which are neutrons and which are gamma rays. However, as Scott explains, "what you really want is a detector that only interacts with neutrons, because those are the particles that are characteristic of nuclear sources." Unfortunately, with this particular detector technology, neutrons cannot be measured alone because they are always contaminated by gamma rays. It becomes an intriguing problem that has no known solution in machine learning. Prof. Scott is working to solve this problem.



Images reflect carbon-dioxide absorption from the atmosphere over a twelve month period.

He is also collaborating with a professor in Stanford's Department of Global Ecology on a project to determine normal fluctuations in carbon dioxide levels around the world. Taking the data retrieved from satellites, Scott is building a mathematical model of what typical behavior looks like. As deviations arise, earth scientists will determine whether they are from natural (i.e., forest fires, hurricanes) or man-made (i.e., CO^2 emissions) causes.

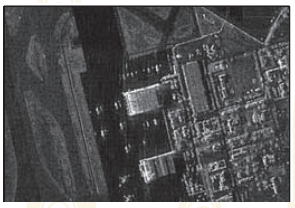
Better Surveillance From Space

For many decades a technique known as synthetic aperture radar (SAR) has been used to take images of an area from an airplane or satellite. Radar allows for the penetration of clouds, fog and dust particles, but getting a clear picture is challenging.

The highest quality images from SAR can be generated only by knowing within a fraction of a wavelength (i.e., in the millimeter range) where the antenna is positioned in relation to the center of the scene being recorded. Researchers have tried to do this heuristically, but there are some very difficult autofocusing situations which require a more mathematical foundation.

David C. Munson, Jr., the Robert J. Vlasic Dean of Engineering, has been working with his group to develop an autofocus algorithm that will generate the best focused images possible. "We now have a suite of algorithms that we derived based on

Synthetic aperture radar image that is defocused due to phase errors.

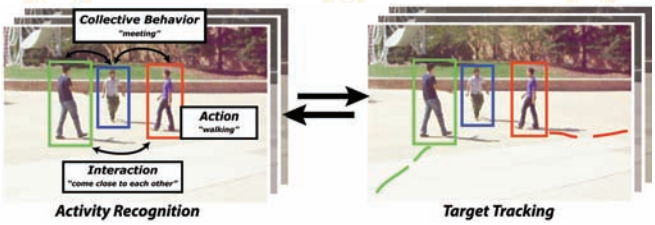


Same image, but properly focused using signal processing techniques.

the fundamental mathematical model of the problem," stated Prof. Munson. "We feel as if we've gotten to the bottom of the autofocus problem."

Computer Vision for Safe Driving and More

The human mind has a remarkable ability to instantly process hundreds of images seen by the human eye, which then impacts individual behavior. When we want a computer to attempt the same thing, we enter the realm of computer vision, and the work of Prof. Silvio Savarese.



Computer vision algorithms enable tracking of individuals as well as an understanding of what they are doing.

One application of his research is to make cars safer on the road, which has led to several collaborations with the automotive industry. In recent work, Prof. Savarese is helping computers not only track and identify pedestrians with the use of a single uncalibrated and moving camera, but also figure out what they are doing (talking, walking, standing in line, etc). His algorithms allow for tracking even in crowded and changing environments.

Once a computer is able to determine what is going on in a scene, it can use that information for additional applications such as indexing photos and videos online, or surveillance monitoring. Prof. Savarese is also working with Prof. Todd Austin, a computer scientist at Michigan, on a specific application of his research that will help the blind using assistive technologies.

Computer vision techniques are naturally suited to robotic applications, and Prof. Savarese has collaborated with computer science colleague Prof. Benjamin Kuipers as well as individuals in industry to help robotic systems intelligently interact with their environment.

Construction Progress and Safety

Prof. Savarese also applied computer vision techniques to the problem of efficient construction site monitoring. Working with Prof. Feniosky Peña-Mora (Dean of Engineering and Applied Science at Columbia University), and his former student Prof.

Mani Golparvar-Fard (Assistant Professor of Construction Engineering & Management at Virginia Tech), he pioneered a method to automatically track structural changes, and enabled data to be collected simply and inexpensively through a process called Four-Dimensional Augmented Reality (D^4AR). The technology generates a 3D map of the site for a given point in time (time is the fourth dimension). This information can be immediately transmitted to off-site locations, and is expected to greatly facilitate work at construction sites. The three researchers recently co-founded a company to commercialize the technology.

Music Signal Processing

Signal processing technology has transformed the music industry. It is apparent in live performances (microphones, speakers, audio mixers, etc.), and has enabled these performances to be heard on your mobile device or home sound system. In more recent applications, signal processing techniques are being used to transcribe, index, and even classify music.

In related work, Prof. Greg Wakefield has applied signal processing technology to vocal pedagogy. He first mimics the sound of a singer's voice electronically, and then modifies it to approach the sound desired by the teacher. Prof. Wakefield and his collaborator on the project, opera singer and vocal instructor Prof. George Shirley, demonstrated the process at a vocal pedagogy workshop. The vocal instructor said it would have taken six months to get the student to do what was accomplished in minutes using this technique.

Prof. Wakefield would also like us to be able to put on headphones and hear the sounds of the New York Philharmonic, or David Bowie, as if each original sound of the orchestra or band were coming from a unique point in space. He and his student successfully rendered 40 unique sound sources – and they did it with the same computational power as needed for a single source.

He is currently collaborating on spatial-audio techniques with Prof. David Kieras, a computer science colleague who developed EPIC, a cognitive architecture that emulates humans doing complicated tasks. "EPIC has a well-developed visual model," explained Wakefield, "but it's never been able to hear very well. We're trying to help EPIC hear."

Processing Textures for Image Compression

As raw photographic images continue to increase in file size, it is increasingly desirable to be able to save and transmit compressed versions of the images quickly and easily. JPEG is a typical method of image compression, but it does a poor job of rendering textures in an image. A texture can be thought of as a pattern that is repeated with enough similarity to seem identical or closely related from one portion of the pattern to another; examples include a roof, sand, a collection of rocks or flowers, or a knitted sweater.

Using a method called Matched Texture Coding (MTC), Prof. David Neuhoff and a team of researchers that includes Prof. Thrasyvoulos Pappas of Northwestern University have developed a method to compress images containing textures efficiently while retaining good image quality. When a variety of results were shown to human subjects, the MTC method generated images that were rated equal or superior to those compressed by JPEG and other existing algorithms.

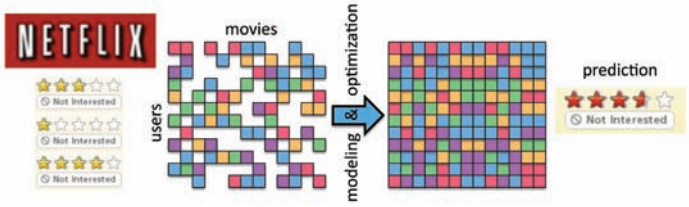
MTC

JPEG

A key to the success of MTC is the development by these researchers of a new metric, called the Structural Texture Similarity Metric (STSIM), for judging the perceptual similarity of two patches of texture. STSIM can also be used for automated indexing and retrieval of images containing texture.

Working Around the Holes in Big Data Applications

Many modern signal processing applications require algorithms that can operate despite missing data. For example, consider applications of computer network monitoring and environmental sensor networks, where we need algorithms to detect anomalous events like bot attacks or high levels of industrial run-off in a river. In both cases, isolated measurements may get lost when a network connection goes down, and the prediction algorithms need to take this into account. Similarly, certain pieces of information may be unknown in collaborative filtering applications where algorithms recommend certain actions be taken – for example when an algorithm recommends a movie to a Netflix user, or recommends a genetic experiment to a medical researcher. The existence of missing data changes the way traditional algorithms operate.



Netflix users enter <1% of the entries that comprise their movie ratings matrix. Algorithms are being designed to predict the rest.

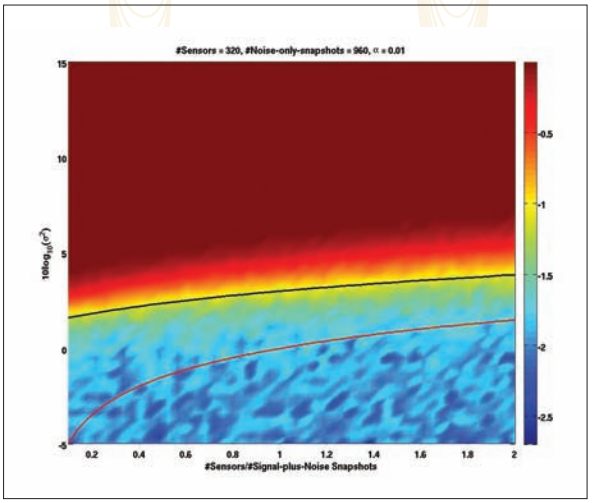
Prof. Laura Balzano is developing novel algorithms that are applicable to these modern signal processing applications, particularly those dealing with massive data sets where some information is not known. Examples include mobile health monitoring, urban sensing, collaborative filtering, computer network monitoring, environmental sensing, electronic medical records analysis, biological networks, and social network mining. She uses tools of optimization and statistical signal processing to develop and analyze algorithms for prediction, detection, and learning from data.

A New Systems Information Theory for Sensing Systems

With today's proliferation of miniature sensors creating sensor networks, there are now a multitude of signals coming from sensors that are communicating with each other as well as a host. New theory is needed to address how information is gathered and interpreted in these current and next-generation sensing systems. As Director of a newly-established Multidisciplinary University Research Initiative (MURI), [see pg. 18] Prof. Hero intends to lay the foundation for a new systems information theory that can be used to design the next generation of autonomous and adaptive sensing systems. Prof. Raj Nadakuditi is an investigator on the project.

Finding When Signals Can be Detected in Data

One basic problem in gathering information from sensors is determining at what point we can differentiate meaningful signals from the noise of irrelevant information. The relationship between the signal and the noise is called the signal-to-noise



Random Matrix Theory predicts when a signal is detectable in a noisy dataset.

ratio, or SNR. In any given system, there is an SNR threshold above which a signal can be reliably detected, and below which it cannot - but where does that threshold lie? Using random matrix theory, Prof. Nadakuditi has developed a broad theory for predicting where that threshold lies. The theory can also be applied to applications as diverse as radar, sonar, wireless communications, and econometrics, and for designing algorithms that attain this limit.

Focusing Random Matrix Theory on Light and Networks

Prof. Nadakuditi was intrigued when he read published experimental results showing that opaque materials could be used as lenses with tighter foci than cheap glass lenses. Working with colleagues in optics (Prof. Steve Rand) and electromagnetics (Prof. Eric Michielssen), he is currently developing the random matrix theory needed to fully understand the fundamental limits of how much light or energy can be transmitted through mediums that are highly reflective, and is testing his theory in a lab setting. "This is an interesting science problem that could only have been cast and resolved through random matrix theory," stated Prof. Nadakuditi. Potential future applications include biological imaging through tissues.

In addition, he is collaborating with Mark Newman, the Paul Dirac Professor of Physics, on a project that applies random matrix theory to the investigation of complex social, biological, and technological networks. Taking an example from social networking, information about a wide range of individuals' social preferences in Facebook can first be represented in a matrix where a 1 in the matrix represents a connection between two individuals while a zero represents no connection. Prof. Nadakuditi is investigating the limits of when information, such as what types of social communities these individuals might belong to, i.e., book clubs or softball teams, can or cannot be extracted.

In these and a variety of other applications, random matrix theory is proving to be very suitable for these types of high-dimensional streams of information, and is being applied to many disciplines of science, engineering, and finance.

Tech Transfer

Michigan's signal processing research extends far beyond the laboratory walls. Faculty and students are working closely with industry, generating patents, and launching startup companies.

For example, Prof. Savarese recently co-founded the company Vision Construction Monitoring, LLC, with plans to offer his D^{4}AR modeling technology to the construction industry. Prof. Munson co-founded the company InstaRecon in 2003, which produces software for fast image reconstruction in computer tomography. Their goal is to have the algorithms used in hospital scanners.

Quantum Signal, LLC was co-founded in 2000 by Professor Emeritus Bill Williams and his student Dr. Mitchell Rohde (BSE EE, MSE EE and BioE, PhD BioE). This local company builds products and technologies based on state-of-the-art algorithms and software, and has significant activity in robotics, biometrics, video analysis, and simulation.

Prof. Fessler's research played a part in General Electric's Veo technology for CT images at lower radiation doses, and Prof. Hero's technology allows pathologists at U-M hospital to make improved diagnoses based on an individual's blood signature. In addition, several faculty members publish their software and specially-designed algorithms on their web pages to assist the entire research community.

Finding the Sweet Spot

While signal processing research at Michigan is often driven by real-world applications, our faculty prefer to work on projects that push existing theory into new directions, or even better, that demand new theory. "With the mathematics on our side," said Prof. Hero, "we are able to focus on analysis – predicting performance, and predicting where the next sweet spot is where we can develop algorithms that will do things that haven't been done before." ●

When Democracy and Technology Collide

Prof. J. Alex Halderman is a prominent security researcher whose work has thrown a spotlight on the thicket of security issues surrounding electronic voting machines and Internet voting. He has also led the development of new anti-censorship technology designed to support freedom, government transparency, and participative democracy throughout the world.

Prof. Halderman received his PhD in Computer Science from Princeton in 2009 and joined the faculty at Michigan the same year. He has rapidly become a noted security expert in the area of computer security and tech-centric public policy, where his research projects have dealt with electronic voting, software security, data privacy, anticensorship, digital rights management, and cybercrime. He has taught EECS 588, Computer and Network Security, and EECS 398, Introduction to Computer Security. This fall, he is teaching "Securing Digital Democracy," a massive open online course through Coursera.

Poking Holes in the Security of US Electronic Voting Machines

Prof. Halderman's fascination with what happens at the intersection of democracy and technology took root early, and he began research into this area while a graduate student at Princeton. In 2006, an anonymous donor gave his research group an electronic voting machine. The system was a Diebold AccuVote TS touchscreen system, which was the most widely-used in the country. The AccuVote TS is a direct-recording electronic (DRE) system, which stores votes in computer memory. With DREs, absolute trust is placed in the hardware and software of the voting machines.

At the time, the Diebold company had been the subject of significant controversy: researchers were doubtful that the machines were secure; the Diebold source code had leaked to the Internet and the academics who had looked at it had concluded there were security problems; but the company denied the issues and no researcher had ever been able to obtain and study an actual system.

With the AccuVote TS in hand, Halderman's group conducted the first academic security review of a voting machine actually being used in elections. What they found was disturbing: with as little as 60 seconds of physical access to the machine, an attacker familiar with the system could insert vote-stealing software which would change the results the machine reported without leaving any electronic traces, and could also insert a vote-stealing virus that could spread from machine to machine over the course of an election, potentially spreading to machines across a state and changing state-wide results.

The AccuVote TSx, like other common types of DRE voting systems, is widely used without a voter-verifiable paper trail.

In the wake of these findings, a number of states commissioned studies of their electronic voting infrastructure. Halderman played a central role in the review of California's systems, which was commissioned by Secretary of State Debra Bowen. After testing, the researchers determined that it wasn't just one manufacturer's system that had security problems: all of the systems in use in California had largely similar problems. They could all be tampered with fairly easily to change how votes were recorded.

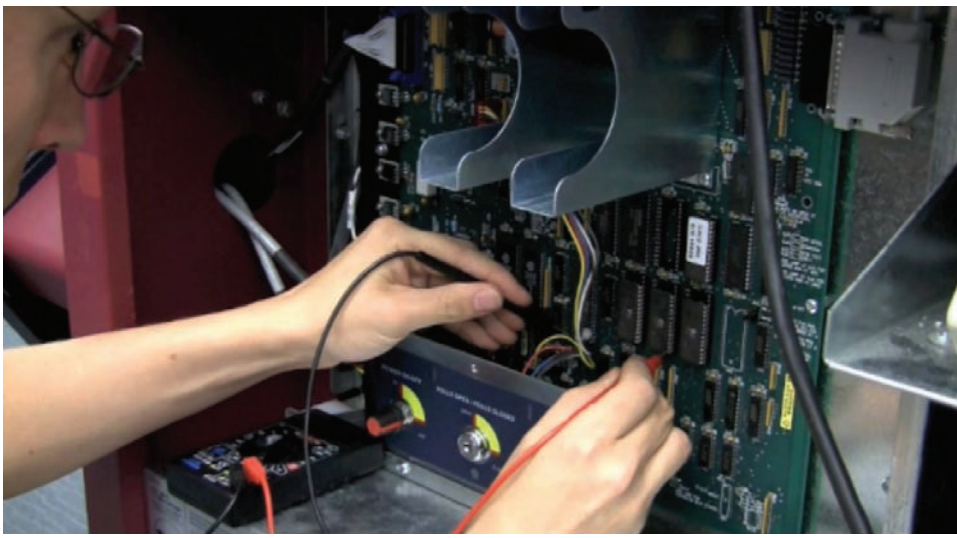
The larger issue identified by the researchers was that because a DRE voting system doesn't produce a physically verifiable paper trail, the results it reports have to be considered suspect. Voting machines can be programmed by an attacker to output specific results; the machines can malfunction and output incorrect results without any direct evidence of that happening, or they can operate just fine. But an observer can't tell the difference between these scenarios. The machines are simply black boxes where the counting is supposedly taking place, but without a mechanism for verifying or recounting votes one is hostage to the opaque nature of computing.

Instead of diving wholesale into electronic voting, the question that Halderman believes we should ask is, "Where can we use technology beneficially to make elections more convenient, more accessible, and more secure?" He points to post-election auditing and recounting as secure applications in which to involve computing technology in the election process without having to actually place full trust in the computers. Halderman's research has shown that a post-election audit can be conducted with the assistance of computer scanners and computer hardware and do a statistical spot check to about 99% confidence while humans perform only a very tiny fraction of the work that would be required if people were to perform a recount by hand. But the ability to audit assumes that a paper record of the voter's intent is generated during voting.

More Examples, From Return-Oriented Programming to Pac-Man

Since joining the faculty at Michigan, Prof. Halderman's work has included analyzing additional voting systems used in the United States and abroad. In one study in 2009 with colleagues from the University of California San Diego and Princeton, he examined a Sequoia AVC Advantage, an electronic voting system used in New Jersey, Louisiana, and other states. In that study, the researchers used a technique to gain control of the system known as "return-oriented programming" which did not exist at the time the system was designed. Return-oriented programming is a powerful systems security exploit that generates malicious behavior by combining short snippets of benign code already present in the system.

That study raised the question of whether voting systems designed to be secure today can remain secure over their intended design lifetime. Halderman points out that when designing systems 10 or 20 years ago, the system designers could never have anticipated all of the attacks to the systems that are now possible. "Extrapolating forward," he says, "it seems equally impossible for system builders today to anticipate the defenses required in order for the systems to remain secure over a future multi-decade operating lifetime."



Reverse engineering the hardware on a Sequoia AVC Advantage system.

In 2010, Prof. Halderman and Ariel J. Feldman, a colleague from Princeton, obtained and hacked a Sequoia AVC-Edge voting system, which is an electronic voting system used in Virginia. Their particular unit was last used in the Williamsburg, Virginia 2008 primaries. In celebration of the 30th anniversary of the iconic arcade game Pac-Man, the two researchers turned the machine into a Pac-Man machine, further illustrating that a determined individual or group can indeed reprogram voting machines to behave in virtually any manner desired.

The classic arcade game Pac-Man running on a Sequoia AVC-Edge voting machine.

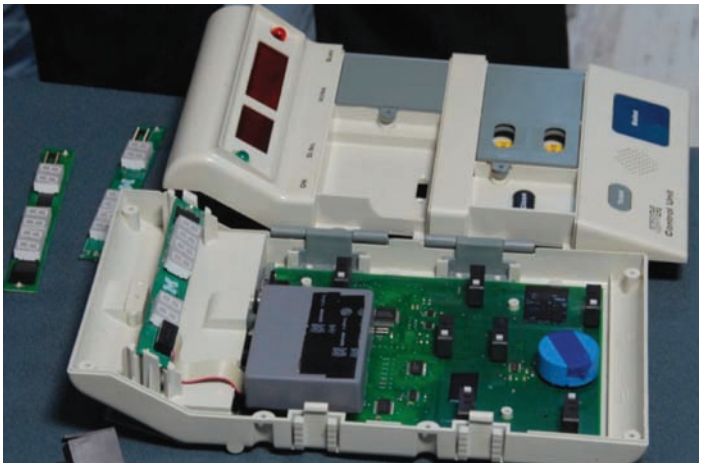
EVMs in India: Denial, Reprisal, and – Perhaps – Acceptance

Although most of the research into the security of electronic voting machines has taken place in the US and Europe, most of the world's democracies are in other regions, and many have adopted electronic voting with very little scrutiny. For this reason, in 2010 Prof. Halderman joined forces with Indian technologist Hari K. Prasad and Netherlands-based technology activist Rop Gonggrijp to investigate the use of electronic voting in India. Almost the entire population of India votes on electronic voting machines, known there as EVMs. In 2010, there were approximately 1.4 million of the machines in use in India, all of the DRE (paperless) variety.

After conducting their study, the trio of researchers revealed that the EVMs used in Indian elections were vulnerable to fraud. Even brief access to an EVM could allow a criminal to alter election results. They published a video in which they were able to demonstrate two types of attacks against a real Indian electronic machine. One attack involved replacing a small part of the machine with a look-alike component that can be silently instructed to steal a percentage of the votes in favor of a chosen candidate. These instructions can be sent wirelessly from a mobile phone. Another attack uses a pocket-sized device to change the votes stored in the electronic voting machine between the election and the public counting session (which in India can be weeks later).

Halderman with colleagues Hari Prasad and Rop Gonggrijp and the Indian EVMs they investigated.

The researchers were also surprised to find that the vote-counting software in the Indian EVMs was programmed into so-called "mask programmed microcontrollers," which do not allow the software to be read out and verified. Because these chips are made in the US and Japan, this has led to a situation in which nobody in India knows for sure what software is in these machines or whether it counts votes accurately.



An Indian EVM with a vote-stealing "look-alike" LCD installed.

These researchers' findings were at odds with claims made by the Election Commission of India, the country's highest election authority, which at the time maintained that weaknesses found in other electronic voting systems around the world did not apply to India's EVMs. On a trip to India after the research results were published, Prof. Halderman was detained and prohibited from speaking about his work. For his troubles, Hari Prasad was for jailed for a time. Prasad later received the Pioneer Award from the Electronic Frontier Foundation for his work.

Since its initial reaction against the findings, the Indian Election Commission has taken steps to address the concerns, prototyping systems that adopt many of the changes recommended by the research team, including the use of a paper record for verification.

Internet Voting: Even More Unpredictable Territory

A new area of concern in the US is the introduction of Internet voting. Although it sounds easy and convenient, Internet voting poses security challenges that are an order of magnitude greater than those for electronic voting machines housed within polling places, because attacks can come from all over the globe and can employ a variety of spyware and malware to change votes or the way in which they are recorded.

In 2010, the Washington, DC Board of Elections and Ethics held a mock election to test the security of a proposed new system that would give the city's 2,000 overseas and military voters the option of returning votes online rather than by traditional postal mail. During the mock election, security researchers were invited to test the system.

Prof. Halderman and his research team – graduate students Eric Wustrow and Scott Wolchok, and Dawn Isabel, a member of the U-M technical staff – participated in the test. Less than 48 hours after the system came online, the researchers were in complete control of the election server. Using a vulnerability they uncovered (known as a "shell-injection" attack), they were able to replace all the votes with ballots for candidates of their own choosing. They also rigged the system to replace any future votes, revealed the secret ballots of other test participants, and uncovered the passwords for routers and switches used in the core DC network. After clearing their tracks in the system logs, the team left a distincting calling card: they modified the system to play the Michigan fight song after accepting each voter's ballot. Nevertheless, it took almost two days before DC election officials noticed anything was amiss.

As a result of the Michigan hack, DC officials decided against accepting real votes over the Internet. Instead, they opted for a solution that Halderman says is far more sensible and less risky: allowing absentee voters to download blank ballots, print them out, and return them by mail. Voting over the Internet safely, says Halderman, will require solving some of the most challenging problems in computer security. This presents fascinating research opportunities, but it may be decades—if ever—before Internet voting can be made secure.

Telex utilizes an invisible tag to disguise connection requests to banned content.

Anti-Censorship on the Internet: A Little Help for Fledgling Democracies

More recently, Prof. Halderman has begun studying democratic engagement and the technologies that can support democratic participation in repressive societies. An increasing number of countries are employing draconian Internet censorship, which blocks access to web sites that the regimes find objectionable. Especially since the Arab Spring, there has been an increase in the pace and sophistication of investment in repressive technology to limit Internet access.

Halderman's research team, including graduate students Eric Wustrow and Scott Wolchok, and Associate Professor Ian Goldberg at the University of Waterloo, has developed a technology called Telex, which is designed to combat such censorship.

Telex disguises requests for connections to censored content as connections to innocuous uncensored parts of the Internet. This is done by using cryptography and steganography so that censoring governments cannot distinguish between requests for censored and uncensored material. The grand vision for Telex is that when it is employed, censors will need to either pull the plug on the Internet completely or accept the fact that citizens in their countries will be able to access whatever content from abroad they want. In the long run, this will support people's ability to have a voice within their own counties, to participate in gaining access to and sharing information worldwide, and to participate in the governance of their own societies. ●

Prof. Halderman's team breaks into the Washington, DC Internet voting system.

Research Briefs

C-PHOM: New NSF Center Explores New Ways to Manipulate Light at the Nanoscale

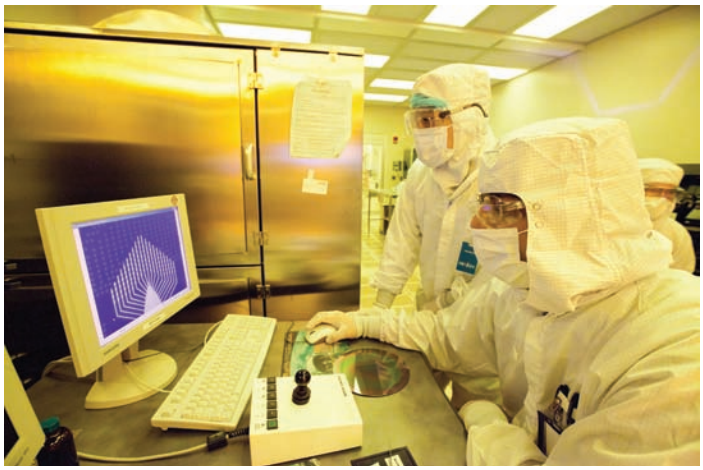
A new $13-million National Science Foundation center, called the Center for Photonic and Multiscale Nanomaterials (C-PHOM), will develop high-tech materials that manipulate light in new ways. Photonics is the study and use of light to transmit and store information, as well as to image things humans can't see with unaided eyes. The research could enable advances such as invisibility cloaks, nanoscale lasers, high-efficiency lighting, and quantum computers. "Advances in photonics depend critically on new materials, and this new center brings together top minds in electrical engineering, materials science, and physics," said Prof. Ted Norris, C-PHOM Director.

The Center has two major research thrusts. One group will focus on improving wide bandgap semiconductors such as gallium nitride, which could make possible quantum emitters that release one photon, or light particle, at a time and could advance quantum computing and quantum information processing. This thrust is led by Pallab Bhattacharya, Charles M. Vest Distinguished University Professor, and includes Profs. P-C Ku, Jamie Phillips, Duncan Steel, and Rachel Goldman (Materials Science and Engineering and EECS/ECE).

C-PHOM
Center for Photonic and Multiscale Nanomaterials

The second research thrust will develop better metamaterials, which are artificial subwavelength-structured materials that enable scientists to make light act in ways it does not behave in nature. Metamaterials could potentially be used to bend light around objects, making them invisible, and allow us to see inside biological cells with unprecedented resolution. Leading this group is Roberto Merlin, the Peter A. Franken Collegiate Professor of Physics. His team will work in close collaboration with researchers at Purdue, in addition to his colleagues in EECS/ECE: Prof. Tony Grbic, Jay Guo, and John Schotland (Mathematics and EECS/ECE).

Artificial Synapses Could Lead to Advanced Computer Memory and Machines That Mimic Biological Brains



In a step toward computers that function like complex biological brains, Prof. Wei Lu and researchers at HRL Laboratories have built a type of artificial synapse based in part on memristors. Memristors combine the functions of memory and logic. Key to the accomplishment is Prof. Lu's development of the first functioning "memristor" array stacked on a conventional complementary metal-oxide semiconductor (CMOS) circuit. These memristor arrays allow computers to mimic the parallel processing of a brain, and are part of a new integrated hybrid electronic circuit developed by the team of researchers. This technology enables the development of intelligent machines that can learn from their environments and perform complex tasks such as planning, decision making, and navigation.

Talking Book to Help Tackle Rural Health, Hunger Challenges

Prof. David Blaauw, Arthur F. Thurnau Professor Peter Chen, and Prof. Prabal Dutta are heading a project to provide low-cost information access to illiterate populations through audio recordings. Their rural audio computer, which they refer to as a "talking book," is conceived around just three custom chips, uses an inexpensive capacitive touch interface, employs inductive communications for peer-to-peer data transfer, and employs content download over GSM voice and FM broadcast as two wide area options. The resulting design point – enabled by aggressive silicon integration – affords a device that can be built for less than $10. The researchers are working with Literacy Bridge, a Washington state nonprofit, to initially bring this technology to market to improve child and maternal health for 25,000 people across Ghana.

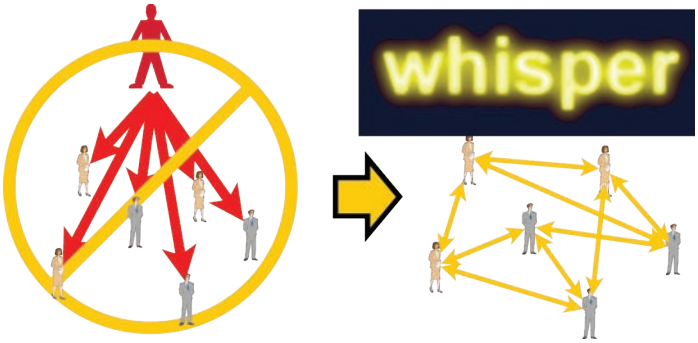
Automating the Computer Debugging Process

Prof. Stéphane Lafortune will bring his expertise to a 5-year, $10M NSF project called ExCAPE: Expeditions in Computer Augmented Program Engineering, based at the University of Pennsylvania. His role will be to automate the complicated, time-consuming and expensive software-debugging process. Prof. Lafortune is the co-creator with Prof. Scott Mahlke of Gadara, a controller that can anticipate and prevent situations that might cause software deadlocks. Deadlocks freeze the machine when different parts of a program get caught in an endless cycle of waiting for one another as they access shared data. In the ExCAPE project, he will extend his research based on discrete control theory to more classes of bugs, not just deadlocks, in a multicore computing environment.

Computational Sprinting Pushes Smartphones Until They are Tired

Smartphones, like laptops, aren't able to reach their full performance potential in large part because of heat generation and dissipation barriers. To address that, "we've proposed a computer system that can perform a giant surge of computation, but then gets tired and has time to rest," says Prof. Thomas Wenisch. He, along with CSE Chair Marios Papaefthymiou and Kevin Pipe of Mechanical Engineering, have developed Computational Sprinting, a hardware/software approach that runs multiple cores for a burst of computation when needed, followed by accelerated cooling. Their work received the Best Paper Award at the *High Performance Computer Architecture Symposium (HPCA).*

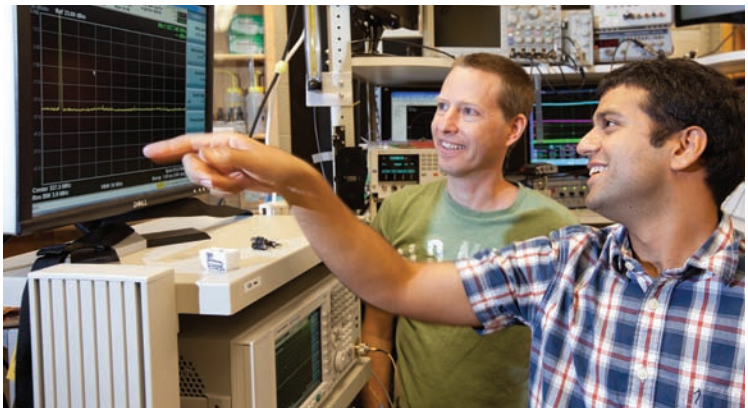
Wireless Communications System Aids in Natural Disasters, Resisting Surveillance



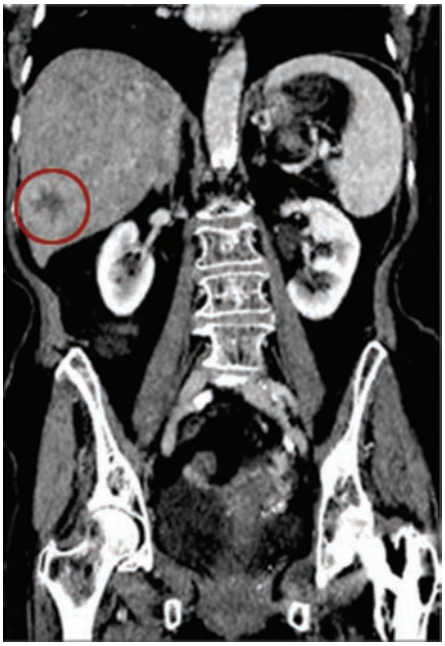
Profs. Robert Dick and Z. Morley Mao are developing Whisper, an easy-to-use, infrastructureless, reliable, secure, and private communication system. This system will operate in the aftermath of a natural disaster when communications infrastructure may be damaged, and will resist surveillance, censorship, and reprisal by providing anonymity and privacy not found in traditional Internet-based communications mechanisms. The system's three-layer architecture provides encryption and is designed for use by people without special training. The project is funded in part by the National Science Foundation.

Cooling (instead of heating) Materials With Light

New findings are increasing scientists' understanding of how light and sound interact in the process called Brillouin scattering. Research scientist Dr. Gaurav Bahl stated, "Since its discovery, it has been textbook knowledge that the component in the Brillouin scattering that amplifies sound, which involves heating, is always dominant. Our work attempts to change this notion, by providing the first experimental evidence of the cooling of an acoustical density wave in a solid using Brillouin scattering." In the lab, Prof. Tal Carmon and Dr. Bahl used light to cool a single mode of vibration of a glass sphere to an effective temperature of -425.2 degrees Fahrenheit (19 Kelvin).



Low Radiation CT Scans Now Available at U-M Hospital



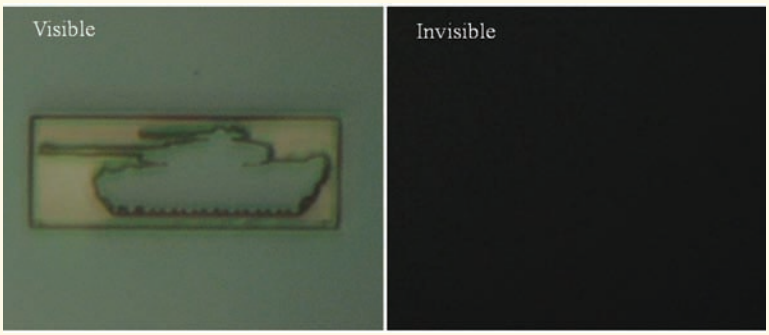
A technological breakthrough is allowing the University of Michigan Health System to be the first teaching hospital in the U.S. to perform CT scans using a fraction of the radiation dose required for a conventional CT image. The new technology is called Veo, and it was ultimately manufactured by GE Healthcare. Prof. Jeff Fessler contributed to the early stages of this work, and is actively working on the next generation of advanced algorithms that will enable faster processing times after a CT scan.

Cell Network Security Holes Revealed

Popular firewall technology designed to boost security on cellular networks can backfire, unwittingly revealing data that could help a hacker break into Facebook and Twitter accounts. Researchers led by Prof. Z. Morley Mao have used Android phones to demonstrate how an attacker could hijack a TCP Internet connection by taking advantage of publicly available information on smartphones, users' willingness to download untrusted apps, and network firewall middleboxes. Their approach demonstrates how spyware can be leveraged to spoof Facebook or Twitter HTTP login credentials to fool many types of popular network firewalls and then gain access to personal account data. The researchers have contacted firewall manufacturers to advise them of the shortcoming.

How'd You Like to Design a Better Cloud?

Applications served from the cloud are driving explosive demand for data center development, and until recently scalable models for evaluating data center architectures have been missing. Researchers led by Prof. Thomas Wenisch have released BigHouse, a simulation tool for data center systems that uses a combination of queuing theory and stochastic modeling to simulate server systems in minutes rather than hours. Their software has been made freely available and their paper on the subject received the Best Paper Award at the *2012 IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS-2012)*.

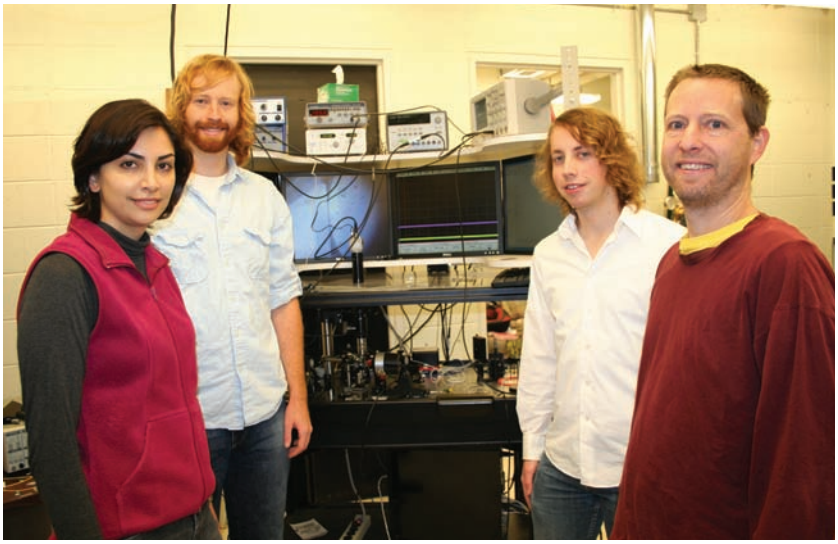


"Magic" Nanocoating Makes Objects Invisible

How do you make an army tank or a stealth airplane virtually invisible? Use a 70-micron carbon nanotube coating that absorbs 99.9% of the light that hits it, says Prof. Jay Guo. This coating completely hides any 3D attributes of an object and makes is appear as a black sheet. Guo theorizes that entire sections of the universe may be hidden if surrounded by light-absorbing carbon nanomaterial gases. Other applications for carbon nanotube material include its use in display screens for ultra-high contrast and sharp picture, and its use as a solar heating device.

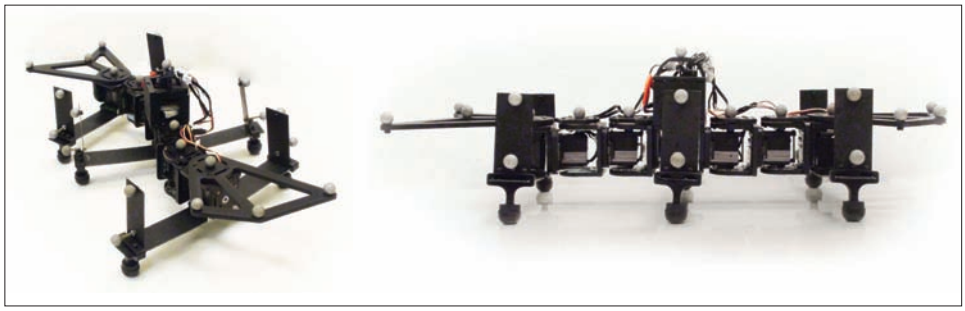
A Smarter Way to Make Ultraviolet Light Beams

Profs. Mona Jarrahi and Tal Carmon have found a better way to build a compact ultraviolet light source with low-power consumption, improving on existing coherent ultraviolet light sources that are power hungry, bulky, and expensive. The researchers have optimized a type of optical resonator to take an infrared signal from relatively cheap telecommunication-compatible lasers and, using a low-power, nonlinear process, boost it to a higher-energy ultraviolet beam. Ultraviolet light sources have applications in chemical detection, crisper medical imaging, and finer lithography for more sophisticated integrated circuits and greater computer memory capacity.



Building Robots to Move Like Animals

With the ultimate goal of identifying, modeling, and reproducing the strategies animals use to combine mechanical and neural control for interacting with physical objects, Prof. Shai Revzen has been working with a robotic hexapod he built with students at his former institution, the University of Pennsylvania. By equipping the robot with softer legs that mimick the leg stiffness found in running insects, they got their robot to run faster while decreasing the number of steps per second and leaving the step length unchanged. It turns out that softer legs, which mimicked the leg stiffness found in running insects, produced an animal-like lateral side-to-side bouncing motion that improved performance. He presented his research at the *15th International Conference on CLimbing And WAlking Robots and the Support Technologies for Mobile Machines (CLAWAR 2012).*



Energy Scavenging Insect Cyborgs to Search and Monitor Hazardous Situations

Sending insects into dangerous environments to scout the area before sending in humans could save lives. The insects would carry tiny backpacks with cameras, microphones, and other sensors and communications equipment that are powered through energy scavenging and mini solar cells. The energy scavenging device would convert the kinetic energy from wing movements into electricity to power the electronic devices. Prof. Khalil Najafi and his team demonstrated several techniques to scavenge energy from the wing motion of actual beetles and convert it into measurable power.

Sensing Soil Moisture Using Compressive Sensing Techniques

Prof. Mingyan Liu is involved in a project called SoilSCAPE (Soil moisture Sensing Controller And oPtimal Estimator), which introduces a new concept for a smart wireless sensor web technology for optimal measurements of soil moisture using *in-situ* sensors. These measurements will be used to validate data received from soil moisture sensors put in Space by NASA. Using compressive sensing techniques, her team minimized the total amount of time the sensor node needed to be "awake" to take active readings and to transmit data. The result was an estimated increase in the lifetime of a wireless node from approximately 6 months to 5 years.

A New Systems Information Theory for Next-generation Sensor Networks

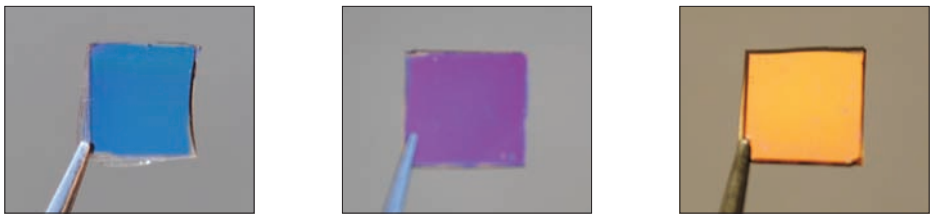
The problem of identifying, extracting, and exploiting the key information gathered by sensors has been an active area of research for several decades, yet a general solution remains elusive, especially for autonomous and distributed sensing systems. A new multi-institution research program based at U-M has the goal of laying the foundation for a new systems information theory that applies to both general controlled information gathering and inference systems with mission planning, while accounting for the value of information. This new theory will be applied to current and next-generation sensing systems.

The research is being conducted under a new five year, $5.25M, Multidisciplinary University Research Initiative (MURI), called: Value-centered information theory for adaptive learning, inference, tracking, and exploitation. Al Hero, R. Jamison and Betty Williams Professor of Engineering, is PI of the MURI, and Prof. Raj Nadakuditi is an investigator on the project. Other institutions included in the MURI are Massachusetts Institute of Technology, Arizona State University, The Ohio State University, University of California, Berkeley, and University of California, Los Angeles.

Making Better Sense of the World

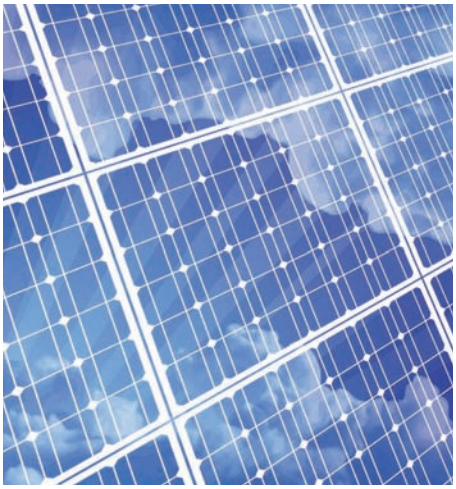
Imagine dozens or even hundreds of miniature sensors informing us about climate conditions, water quality, bodily health, structural safety, and air pollution – and also tracking movement, monitoring plant operations, and even detecting forest fires. This is our future, and in some cases is happening now, but how can we make these tiny sensors work together in perfect harmony?

A new 5-year $2.5M research program funded by the National Science Foundation, called "Controlled Sensing, and Distributed Signal Processing and Decision Making in Networked Systems," aims to address fundamental issues that arise in networked systems so that they can operate with maximum efficiency. This is especially critical as the individual sensing devices continue to be scaled down to millimeter size and even smaller. "We will be using basic ideas from stochastic optimization, distributed computation, and probability theory to develop novel methodologies that address the underlying challenges," stated Prof. Demos Teneketzis, PI for the project. Other faculty involved in the project are Profs. Achilleas Anastasopoulos, Sandeep Pradhan, Mahta Moghaddam (University of Southern California), and Prof. Venugopal Veeravalli, co-PI (University of Illinois-Urbana-Champaign). The methodologies developed will be tested on related research that involves smart environmental sensor webs.



Better Displays Using Colored Solar Cells

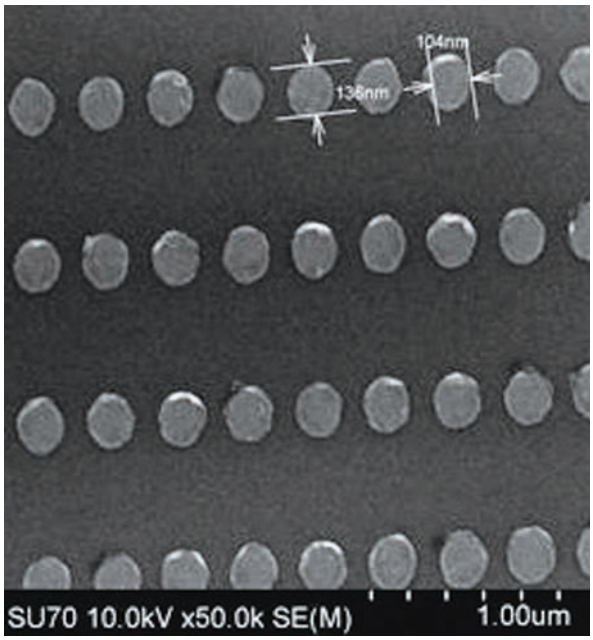
A new kind of screen pixel doubles as a solar cell and could boost the energy efficiency of cell phones and e-readers. Prof. Jay Guo has developed a reflective photovoltaic color filter device that can convert absorbed light to electricity. His team created the new filter by adding organic semiconductor solar cells to an ultra-thin color filter that is 100x thinner than traditional colorant-based filters. The technology could also potentially be used in larger displays to make energy-harvesting billboards or decorative solar panels.



A Bright Future for Pervasive Organic Solar Cells

Solar cells can be made with a variety of materials, and our faculty are experimenting with several options for different uses. Prof. Stephen Forrest, William Gould Dow Professor of Engineering and VP for Research at U-M, works with organic materials, which he says "are not very different from the inks in an inkjet printer or the dyes used in clothing. These materials are light, malleable, and relatively inexpensive. In principle, they can be put down very cheaply on plastic films, metal foils and other flexible substrates." He is working with Global Photonic Energy Corporation to make this vision of pervasive solar cells – imagine them painted on windows to get a feel for how pervasive – a reality.

Researchers Funded to Create Processors That Run Without Battery Power

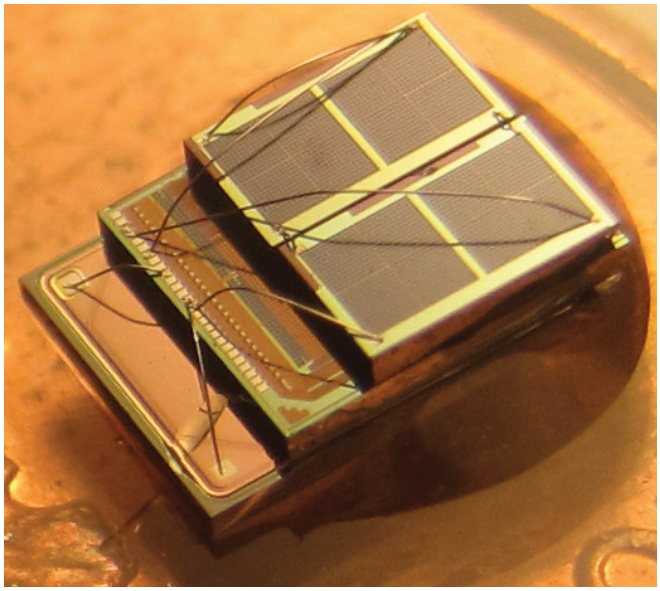


Prof. Pinaki Mazumder is part of a consortium with researchers from three other institutions that is pursuing an effort to create energy-efficient computing devices with even more processing power packed into a single chip, while also potentially cutting out the need for battery-run computer circuits. Their approach replaces the transistors that are currently used in electronic chips with tiny nanomagnets that can also process digital information, reducing heat dissipation by as much as one thousand to ten thousand times.

A potential outcome of the project is the prospect of building processors that can run without a battery because they can harvest energy from their ambient environment. This type of system could be ideal for medical devices such as a processor implanted in an epileptic patient's brain that would monitor brain signals to warn of impending seizures. Such a device would operate by harvesting energy only from the patient's head movements. The research is funded by the National Science Foundation and the Nanoelectronics Research Initiative of the Semiconductor Research Corporation.

Fighting Acne With Lasers

A tabletop-sized laser developed by Prof. Mohammed Islam is designed to melt the fat that leads to acne, without burning surrounding tissue. Its 1,708 nanometer, infrared beam can reach glands more than 1.5mm beneath the skin. The beam's unique wavelength targets oil-producing subaceous glands, which can lead to acne.



What's Hot in 2012?

According to *EE Times*, it's wireless sensor network technology, coming in at #2 on their list of top "20 hot technologies for 2012." They show this system created by Prof. David Blaauw and Prof. Dennis Sylvester to illustrate their point. The researchers built the world's smallest sensor (in 2010), as well as the first true millimeter-scale full computing system (in 2011).

Data Mining Finds EKG Abnormalities That Point to Heart Attack Fatalities

Prof. Zeeshan Syed, along with researchers from MIT, Harvard Medical School, and Brigham and Women's Hospital in Boston have used data mining techniques to identify subtle, previously unknown "computational biomarkers" of heart damage in the EKG records of patients who have recently suffered heart attacks. These markers could help doctors to identify which heart attack patients are at high risk of sudden cardiac death. "Today's methods for determining which heart attack victims need the most aggressive treatments can identify some groups of patients at a high risk of complications. But they miss most of the deaths – up to 70 percent of them," said Prof. Syed.

Predicting Who Will Get the Flu

Why do some folks who take every precaution still get the flu, while others never even get the sniffles? It comes down to a person's immune system response to the flu virus, says Alfred Hero, R. Jamison and Betty Williams Professor of Engineering. In one of the first known studies of its kind, Hero and colleagues from Duke University Medical Center and the Duke Institute for Genome Sciences & Policy used genomics to begin to unravel why some get sick while others don't. They looked at more than 22,000 genes in 267 blood samples, the largest study of its kind.

Energy Minimizing Listening Extends Battery Life for Wireless WiFi Devices

Battery running low again? That's because more than 60% of a device's battery power can be consumed in idle listening time. This may change once new technology developed by U-M researchers is adopted. Led by Kang Shin, Nancy and Kevin O'Connor Professor of Computer Science, the researchers have proposed E-MiLi, which among other things adaptively downclocks the device's radio during idle listening and reverts to full clock-rate when an incoming packet is detected or a packet has to be transmitted. When integrated with 802.11, E-MiLi can reduce energy consumption by around 44% for 92% of users in real-world wireless networks. The researchers' paper on the technique received the Best Paper Award at the *International Conference on Mobile Computing and Networking (MobiCom '11)*.

Mass-producing Tiny Antennas for Future Electronics Through Imprint Processing

The antenna is typically the largest wireless component in mobile devices. Shrinking it could leave more room for other gadgets and features, says Prof. Anthony Grbic. Using innovative imprint processing techniques, he and Stephen Forrest, William Gould Dow Professor of Engineering and VP for Research at U-M, have found a way to produce antennas so small that they approach the fundamental minimum size limit for their bandwidth, or data rate, of operation. This is expected to lead to new generations of wireless consumer electronics and sensors that are either smaller or can perform more functions.

Accessing A World of Hidden Databases

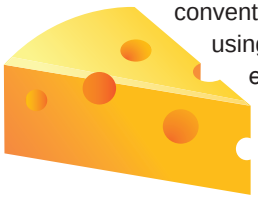
You may not realize it, but when you open a spreadsheet and populate it with data, you may in fact be creating a unique data repository. Spreadsheets, especially within companies, tend to stick around longer than expected and often contain information not found anywhere else. Research led by Prof. Michael Cafarella has produced a mechanism for transforming spreadsheet data into a more traditional database, so that you can get services on top of that data and integrate it with other data. The technique offers the promise of unlocking hidden assets that are currently locked away in hard-to-access files.

Like Parallel Parking, Parallel Programming Needs to Be Easier

Prof. Satish Narayanasamy is investigating solutions that span from processors to languages to shrink the space of legal thread interleavings in a parallel program and thereby simplify the task of the programmer in ensuring correctness. By doing so, he aims to be able to employ sequential programming semantics for parallel performance. If we could get there, programming for parallel processors may become as easy as it is now for sequential processors.

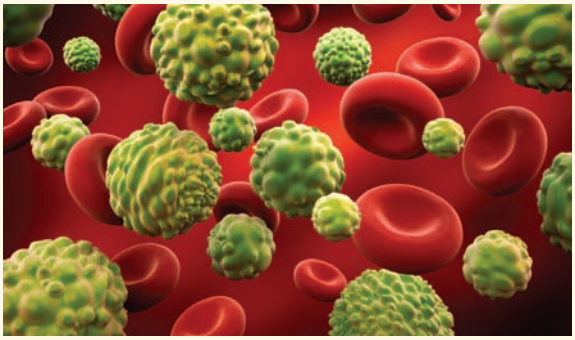
Planning for Holes in your "Swiss Cheese" ICs

Semiconductor chip manufacturers increasingly optimize the size and performance of integrated circuits (IC). The next round of improvements will be achieved by 3-D stacking of conventional 2-D ICs and their integration using through-silicon vias (TSVs). To establish power and data connections between 2-D layers, TSVs require dedicated holes which make component 2-D ICs look like swiss cheese. Prof. Igor Markov notes that such dead space on the silicon die must be planned carefully for the integration to be successful. His group has been funded by the National Science Foundation to develop methods and software tools for multiobjective deadspace optimization to facilitate the 3-D integration of 2-D chips in this manner.



Researchers Funded by NSF to Study IPv6 Adoption

Despite its enormous importance and scale, the core technology that supports the Internet's basic functions, Internet Protocol version 4 (IPv4), has seen little fundamental change over time. With the recent explosion of Internet-connected devices, IPv4 is on the verge of running out of Internet addresses and the looming scarcity threatens not only the Internet's continued growth and stability but also a critical underpinning of the world economy. Research Prof. Michael Bailey and Prof. Z. Morley Mao, alongside a team from the International Computer Science Institute, have been monitoring the impact of this scarcity and the rollout of the next-generation Internet protocol, IPv6. While the community has made great strides in the transition to these new technologies, Prof. Bailey noted in a recent study that, "there is a long road ahead before IPv6 is in parity with IPv4."



Machine Learning for Better Diagnosis of Blood-related Diseases

When doctors need to diagnose blood-related diseases such as leukemia or lymphoma, they often rely on a technique called flow cytometry, which allows for rapid cell analysis. This process is typically performed manually, which is time consuming and subject to human error. Prof. Clay Scott and his team have developed a new approach to automating the "gating" portion of the flow cytometry process using a machine learning technique known as transfer learning. Working with Dr. Lloyd Stoolman at U-M's Department of Pathology, their technique successfully replicated the same results as expert clinicians in test cases.

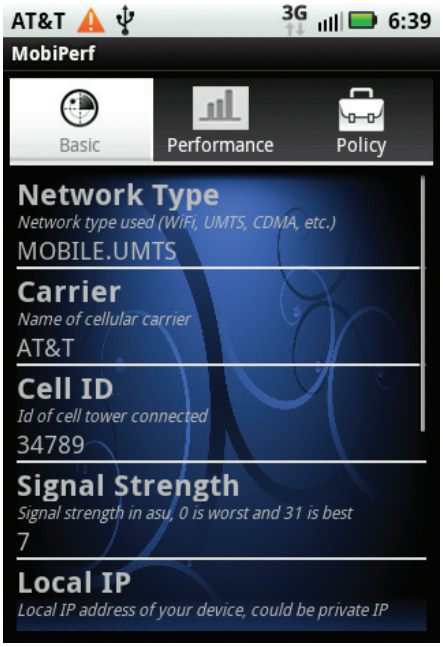
Computer Scientists Funded for First Inquiry into Non-Consumptive Research

A team of researchers including Prof. Atul Prakash is pursuing the first funded investigation of non-consumptive research of a major mass collection of content in partnership with the HaitiTrust Research Center. Non-consumptive research involves computational analysis of one or more books without the researcher having the ability to reassemble the collection. Rather than reading the material, researchers use specialized algorithms to analyze text as a massive data set in a secure environment.

The Sloan Foundation funded project will enable the researchers to pursue a research track around non-consumptive research uses of the HathiTrust digital corpus. At the end of the project, they expect to have cyberinfrastructure in place that successfully demonstrates how non-consumptive research can be carried out safely under the conditions of unintended malicious user algorithms.

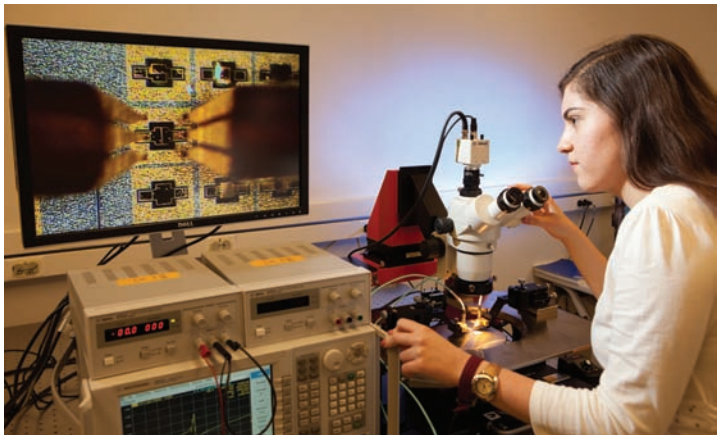
MobiPerf App Allows Users to Capture Rich Set of 3G Network Info

Want to know more about the 3G wireless performance your wireless carrier provides? Researchers led by Prof. Z. Morley Mao have released MobiPerf, a lightweight and accurate mobile network measurement tool designed to collect anonymous network measurement information directly from mobile end users. The downloadable app runs on Android, iOS, and Windows Mobile devices and completes within 2-3 minutes, providing users with network and performance information. MobiPerf helps to identify the bottleneck network behavior for resource-constrained mobile platforms and exposes both the performance and energy impact of mobile network policies on end users. The app won in two categories in the FCC's recent Open Internet Challenge.



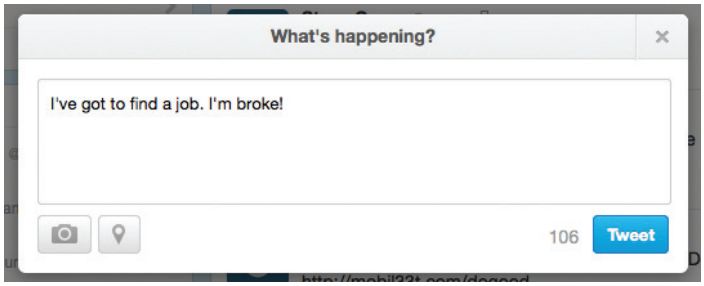
Novel Technology for Uncooled IR Detectors

Uncooled infrared (IR) detectors are used in a variety of applications, including those related to nightvision (transportation, firefighting, surveillance) and radiometry (monitoring blood flow, detecting tumors, and monitoring temperature in manufacturing). Since they don't need to be cooled, they are being used more and more in IR cameras. The Resonant MEMS group, directed by Prof. Mina Rais-Zadeh, has developed a novel technology for low-noise un-cooled detection of infrared radiation using an array of high-Q gallium nitride micro-mechanical resonators coated with a thin-film IR absorber. The IR absorber converts the infrared energy into heat with a high efficiency of more than 90%. Prof. Rais-Zadeh's group has recently demonstrated the highest-performance gallium nitride resonator reported to date, and a prototype of the resonant infrared detector.



Azadeh Ansari, a graduate student working with Prof. Mina Rais-Zadeh, is measuring the frequency response of the gallium nitride resonators.

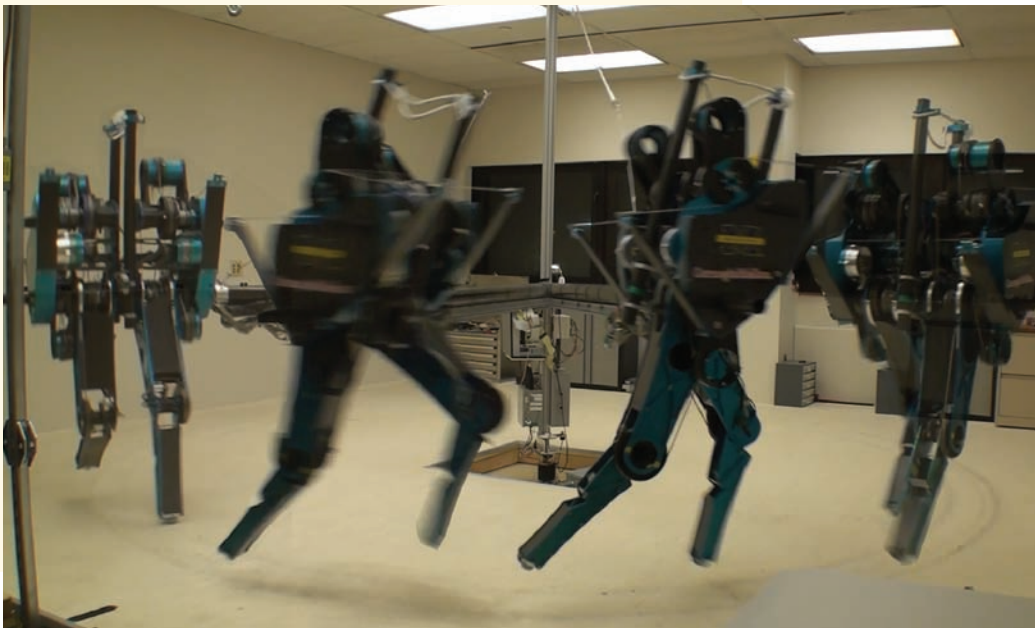
Economic Indicators Mined From On-Line Conversations



Just as you may get a sense of what's in the news by reading headlines, researchers led by Prof. Michael Cafarella have developed a technique for mining on-line communications on a massive scale to provide an indication of economic conditions. The data collected predicts statistics such as unemployment levels at less cost and more quickly than the traditional tools used by the government in producing unemployment statistics.

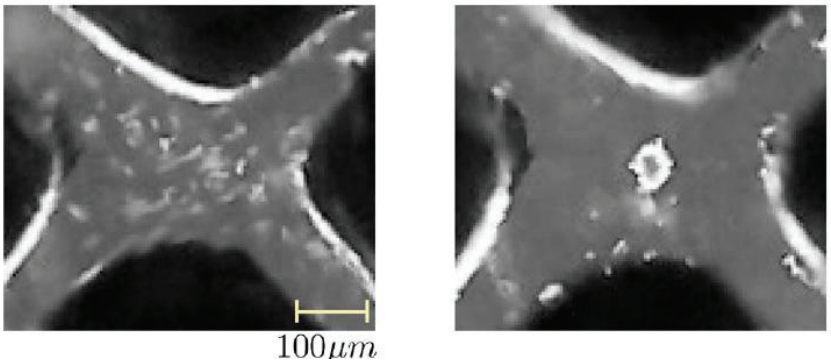
MABEL the Bipedal Robot, Running and Recovering From Falls

MABEL has been making great strides this past year, including earning the title of world's fastest running robot with knees. To classify as a runner, both legs must be in the air at the same time. Her peak pace when she took the record was 6.8 mph. More recently, she became the world's first two-legged robot with a trip reflex. This ability allows her to navigate bumpy terrain with greater ease, and adds to her ability to step up and down stairs. Robots having these abilities are well-suited to rescue missions, where they may need to navigate stairs, step over toys on the floor of a burning house, or traverse rocky terrain in a war zone. Prof. Jessy Grizzle leads the research on MABEL, and her soon-to-arrive successor, ATRIAS.



Manipulating Single Human Cells With an Electrical Force Field

Prof. Kamal Sarabandi and an interdisciplinary team are using electrical energy as a force field to manipulate microscale objects. They developed a novel approach to dielectrophoretic manipulation that makes it possible to manipulate single cells with relative precision. They then use dielectrophoresis (DEP) to manipulate collections of particles or cells of the same type, such as muscle fiber cells. The team includes Dr. Varsos (General Motors/University of Michigan Collaborative Research Lab), Dr. Luntz (Mechanical Engineering), and Dr. Welsh (Cell & Developmental Biology). This novel technique may eventually enable tissue engineering lab experiments.



Left: freely suspended particles. Right: after the activation of the field a cluster of particles is formed in the center of the field.

Managing Large Disk Arrays More Efficiently

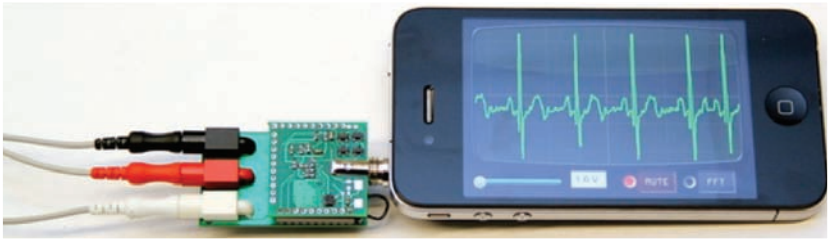
Kang Shin, Nancy and Kevin O'Connor Professor of Computer Science, and research colleagues from industry have developed Maestro, a feedback controller that manages resources on large disk arrays to provide performance differentiation among multiple applications. Maestro monitors the performance of each application and dynamically allocates array resources to applications so that diverse performance requirements can be met without static partitioning. By ensuring that high-priority applications sharing storage with other applications obtain the performance levels they require, Maestro makes it possible to use storage resources efficiently. Their paper on the work received the Best Paper Award at the *8th IEEE International Conference on Autonomic Computation*.

Abdi Zeynu at work in the lab.

Energy-efficient Machines for HEV's and More

Prof. Heath Hofmann is designing a novel induction machine that can be used in variable speed drive applications, such as hybrid electric vehicles. This machine is expected to offer a significant improvement in performance over existing machines. Induction machines are the most common type of motor used in industrial, commercial, and residential settings, and consume a large percentage of all the electrical energy generated in a system. At the same time, the newer technology makes it possible to employ much cheaper materials when compared to the prevalent permanent magnet machines.

HiJack Technology is Taken Up by Systems Builders Worldwide



Prof. Pabal Dutta has led the development of HiJack, a hardware/software platform for creating cubic-inch sensor peripherals for smartphones. HiJack devices harvest power, data, and bandwidth from the phone's headset interface. Since its introduction, Prof. Dutta has open-sourced HiJack and the platform is now available in kit form from SeeedStudio, enabling a new class of small and cheap phone-centric sensor peripherals that support plug-and-play operation. Seeed has received kit orders from accessory builders around the world.

Seeing Through Dust and Darkness for Helicopter Safety

Prof. Sarabandi is teaming up with BAE Systems on the design of imaging radar that will allow helicopter pilots to take off and land safely even in conditions of extreme brownout or whiteout. BAE Systems is leading the $34M effort to develop a next-generation Multi-Function Radio Frequency (MFRF) Advanced Rotary Wing Multifunction Sensor (ARMS) system for helicopter operation. Prof. Sarabandi will design the 94GHz imaging radar.

Modernizing the Nation's Electric Grid for Alternative Energy

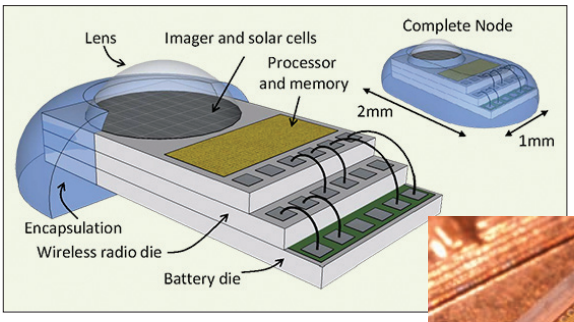
Americans rely on the nation's current grid system to distribute energy to businesses and homes, but the grid was designed to deliver energy that is produced in a steady and reliable manner. Two primary sources of alternative energy, wind and sun, do not offer continuous sources of energy – and they are not available in equal measure throughout the United States. Prof. Ian Hiskens, Vennema Professor of Engineering, is partnering with Prof. Daniel Kirschen at the University of Washington to develop the technology that will allow the nation's grid system to accommodate large-scale alternative energy sources; they are calling it an Energy Positioning paradigm.

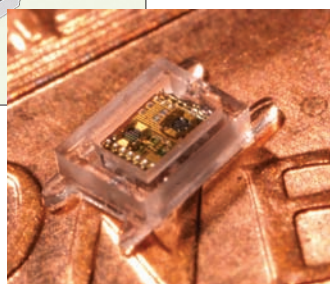
My Wheelchair Knows More Than Yours

Prof. Benjamin Kuipers is pursuing research into the areas of robot learning, perception, exploration, spatial mapping and navigation, and human-robot interaction. He and his group are working on the Intelligent Robotic Wheelchair (now in its second generation), which uses laser range-finders and computer vision to perceive a local indoor environment. Recent research results include computer vision methods for indoor scene understanding, control methods for safe and comfortable motion by the wheelchair, and an efficient method for managing a potentially large number of hypothesized cognitive maps. The research in the Kuipers group is sponsored in part by the National Science Foundation and by the Toyota Technical Center in Ann Arbor.

Taking "Smart Dust" From Fiction to Reality

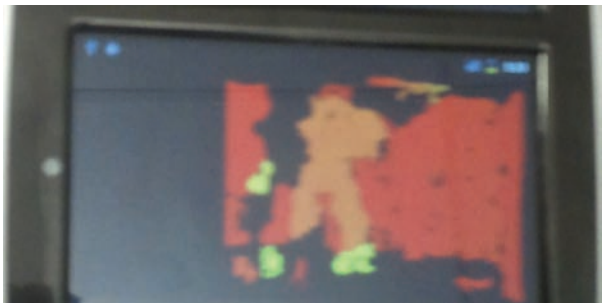
To facilitate widespread research into the next computing frontier that is millimeter-scale computing, faculty will build 100 first- and second-generation cubic-mm size sensor node platforms and disseminate them to other researchers for trials in a wide range of applications. These sensing platforms will incorporate transducers (i.e., imaging, temperature sensing), wireless communication, a high-accuracy timer, processor, memory, battery and energy harvesting, all in a 1mm^3 volume. Current wireless sensor nodes measure at least 1cm^3 and are hampered by short lifetimes. The research is being carried out by Prof. David Wentzloff (PI), Prof. David Blaauw, Prof. Prabal Dutta, Prof. Dennis Sylvester, and Prof. Thomas Schmid, co-PI, from the University of Utah.





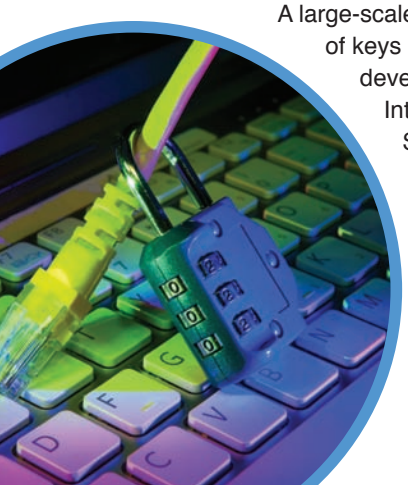
A sensor platform for an implantable intraocular pressure sensor at the target size has already been developed by Profs. Blaauw and Sylvester.

Visual Sonification System Provides Low-cost Aid for Visually Impaired



Researchers led by Profs. Todd Austin and Silvio Savarese have developed a technique for converting the visual properties of objects into sound signals. The Michigan Visual Sonification System (MVSS) utilizes this process to assist the visually impaired in distinguishing different objects in their surroundings. MVSS uses depth information to first segment and localize objects and then represents an object's appearance using histograms of visual features that are converted to sounds. The system then relies on the considerable discriminating power of the human brain to localize and "classify" the sounds, thus enabling the user to distinguish between visually distinct object classes. Funding for the project was provided by the Gigascale Systems Research Center and the National Science Foundation.

Weak Keys Discovered in Network Devices



A large-scale study of RSA and DSA cryptographic keys in use on the Internet has found that significant number of keys are insecure due to insufficient randomness. The research team, including Prof. J. Alex Halderman, developed a tool that can remotely compromise about 0.4% of all keys used for SSL website security on the Internet in a few hours. Among their findings, the reseachers noted that 5.57% of TLS hosts and 9.60% of SSH hosts share public keys in an apparently vulnerable manner, due to either insufficient randomness during key generation or device default keys. According to the researchers, the security flaw largely affects headless and embedded network devices, such as routers, firewalls, and server management cards. These types of devices often generate keys automatically on first boot, and lack many of the physical sources of randomness used by traditional PCs to generate random numbers. The researchers identified apparently vulnerable devices and software from 54 manufacturers and notified those companies about the problems. This work received the Best Paper Award at the *21st USENIX Security Symposium*.

Faculty Help Build Program, Relationship With Addis Ababa Institute of Technology in Ethiopia

During a trip to Africa in 2009, Profs. Todd Austin and Valeria Bertacco visited what was then known as Addis Ababa University to give a talk about Michigan Engineering. On that trip, not only did they find Biruk Mammo, who is now working in Prof. Bertacco's lab as a doctoral student, but they discovered great enthusiasm amongst a number of students for electrical engineering and computer science.

But Austin and Bertacco noticed that AAIT's program in ECE was severely lacking in resources. "Their classrooms were mostly blackboard and book-based and the computer labs were overcrowded," Bertacco said.

The professors set out to change that. They reached out to industry and even into their own pockets to set up a lab that opened in the summer of 2011. Semiconductor firm Xilinx donated field-programmable gate array boards, which are reconfigurable integrated circuits used in digital design classes. NVIDIA donated Compute Unified Device Architecture (CUDA) boards for parallel programming courses and research. Intel provided some computers and the two professors purchased additional computers from the college's Computer-Aided Engineering Network to establish a modern 25-machine computer lab where undergraduates can work on computer engineering projects.

This year, Austin and Bertacco spent sabbaticals at AAIT, continuing their work on establishing collaborations with the institution. In March, they shipped another 10 computers for use in labs, and from March through July they lectured and taught courses for masters level students. Austin created and taught a course on computer security, and Bertacco created and taught a course on fault-tolerant computing. The two also started a reading group for masters students and lecturers, and gave talks on topics such as how to do research and how to prepare for the GRE and apply to grad school.

On July 25, the computers that they had shipped from Ann Arbor in March arrived. "One of the things that we learned," said Austin, "was just how different the culture is in Ethiopia. Many things move more slowly here, and patience is required."

Prof. Bertacco lectures on fault-tolerant computing.

Prof. Austin (right) speaks with students following a reading group session.

Profs. Austin and Bertacco with students from the program.

Resource Available to Assist With Embedded Systems Projects

The Michigan Embedded Systems Hub, headed by Dr. Mark Brehob, is a shared resource for all U-M students, staff, and faculty who are developing embedded system projects. The Hub provides the facilities needed for basic embedded systems work, and now offers training sessions related to embedded systems (PCB design, soldering, and microcontroller basics). The Hub is located at room 1625 in the Beyster Building.

A student finishes a soldering project at the Hub.

Events

CSE's Home Named in Honor of Beyster Gift

In recognition of a $15 million gift to the College of Engineering, the Computer Science and Engineering Building has been named for four-time U-M alumnus Dr. J. Robert Beyster and his wife Betty, with the building receiving its new name at a dedication ceremony on April 11, 2012. In addition to entrepreneurship programs and capital improvements at the college, the gift provides a minimum of $9 million to endow the J. Robert Beyster Computational Innovation Graduate Fellows Program, the largest sum dedicated to fellowships in the College's history.

Dr. Beyster arrives for the building dedication.

Dr. Beyster is a four-time U-M alumnus, founder of the largest employee-owned research and engineering firm in the United States (Science Applications International Corporation), and is the founder and president of the Foundation for Enterprise Development. His wife, Betty, is a graduate of the University of New Mexico, a member of the Achievement Rewards for College Scientists Foundation, and an active volunteer and philanthropist.

In recent years, Bob and Betty have contributed to the College in the areas of experimental biofuels, cloud computing and security, and gene therapeutics. They have also funded a class on employee ownership through the Center for Entrepreneurship.

Celebrating the Birth of a New Science

Close to 500 participants packed the Michigan League Ballroom on October 26, 2011 to attend a symposium celebrating the 50th anniversary of the birth of Nonlinear Optics. The field of nonlinear optics was born in 1961 when the team of Peter Franken, Alan Hill, Wilbur Peters, and Gabriel Weinreich, working in the Randall Lab, observed for the first time the generation of optical harmonics. This discovery led to a revolution in optical physics that has opened up the entire electromagnetic spectrum, making possible laser generated radiation from terahertz frequencies to the X-ray regime. Applications of nonlinear optics range from fiber-optic communications to biological imaging and homeland security. The distinguished group of speakers included Nobel Prize winner Nicolaas Bloembergen. The symposium was organized by Prof. Herbert Winful and Roberto Merlin, Peter A. Franken Collegiate Professor of Physics.

Standing, from left: Marty Fejer, Stanford; Sunney Xie, Harvard; Esa Garmire, Dartmouth; Alex Gaeta, Cornell; Phil Bucksbaum, Stanford; Paul Maker, JPL, rtd; Paul Kelly, OSA
Sitting, from left: Joe Giordmaine, Bell Labs, rtd; Gérard Mourou, ENSTA, U-M rtd; Nicolaas Bloembergen, U of Arizona; Gabriel Weinreich, UM rtd; Alan Hill, AFWL rtd; Michael Bass, U of Central Florida
Front: Steve Cundiff, JILA; Roberto Merlin, U-M; Herbert Winful, U-M

SSP'12 @ MICHIGAN
IEEE Statistical Signal Processing Workshop
August 5 – 8, 2012 Ann Arbor, USA
www.SSP2012.org

The 2012 IEEE Statistical Signal Processing Workshop was held in Ann Arbor, August 5-8, 2012. Prof. Al Hero was General Chair, and he was assisted by several of his Michigan colleagues. Participants gathered at the Michigan League to hear a series of plenary speakers discuss the hottest issues in statistical signal processing research. Sessions focused on SSP as applied to data acquisition and processing, machine learning, biological systems, radar applications, acoustics, materials engineering, networking, sensors, and imaging.

A group from among the 300 attendees of the conference was offered the rare opportunity to be photographed on the field of Michigan Stadium.

Events

Students Learn From the Master at Sid Meier Game Design Boot Camp

In May 2012, 22 senior students or recent graduates from five universities around the country with a serious career interest in the video game design industry attended the first-ever Sid Meier Game Design Boot Camp at CSE.

Organized and run by John Laird, John L. Tishman Professor of Engineering, and featuring legendary game designer Sid Meier (see Alumni Spotlight on p. 58), this intensive, 12-day camp included a series of sessions on game theory and implementation, guest speakers from Microsoft Studios, EA Games, Binary Creativity, Zynga, and faculty from U-M, University of North Texas, and North Carolina State University.

Students, who were all required to have previous programming experience, were expected to brainstorm, design and then implement a new game from the ground up. They also participated in creative exercises, such as designing and playing board games in a group environment. The workshop ended with a showcase at which the campers demoed their working games to each other and the public.

Robotics Day Showcases Research Into Robotics Capabilities

In April, CSE faculty and graduate student researchers displayed some of their projects at Michigan Robotics Day, which took place at the North Campus Research Center in partnership with government and industry participants to showcase regional robotics capabilities and promote Michigan STEM and industry strengths. Projects demoed included Prof. Benjamin Kuiper's robotic wheelchair, Prof. Edwin Olson's MAGIC robots, and CARL, the Car Lab that Prof. Olson shares with Prof. Ryan Eustice of the Department of Naval Architecture & Marine Engineering.

Seven Schools Compete at U-M Programming Invitational

Prof. Kevin Compton, U-M Programming Team Coach, can't get enough competition - so he organized one here. Some of the best student programming teams from Carnegie-Mellon, Chicago University, Harvard, Purdue, the University of Illinois at Urbana-Champaign, the University of Michigan, and U-M Dearborn gathered in Ann Arbor in October 2011 to participate in the first Jump Trading/U-M Invitational Programming Contest.

The competition was organized with assistance from CSE graduate student Mark Gordon, who competed on the U-M programming team in the ACM World Finals in 2011 (2nd place) and 2010 (tied for 14th place) and Dennis Matveyev, assistant coach. Technical support for the competition was provided by Joel VanLaven in the EECS Department.

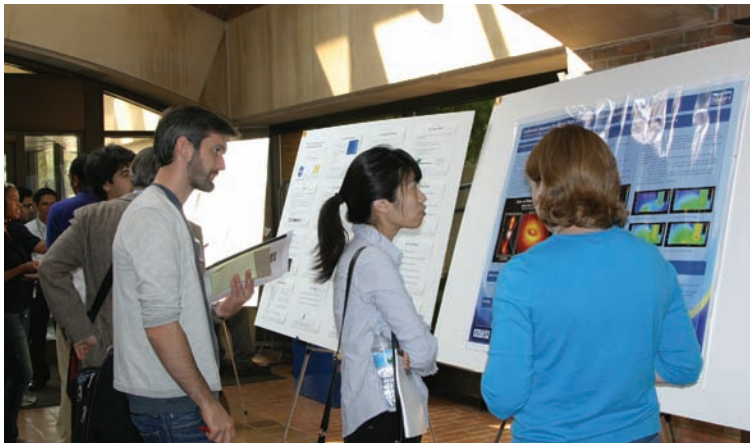
WIMS² Welcomed in California

WIMS², the Center for Wireless Integrated MicroSensing and Systems, held an outreach event in Sunnyvale, CA the afternoon of April 18. More than seventy people attended tutorials and research overviews. The technical topics ranged from wireless and low-power circuits, to MEMS, to microfabricated gas chromatographs. The tutorials were given by members of the research center including the director, Prof. Yogesh Gianchandani. Dr. Andy Oliver, the Industrial Liaison and Principal Staff Scientist, discussed how companies can benefit by working with a university research center. The mission of WIMS² is to advance the design, fabrication, and breadth of the applications for sensor-driven systems through research, education, and interactions with industry.

Events

Plasma Science Graduate Student Symposium

The 2nd Michigan Institute for Plasma Science and Engineering (MIPSE) Graduate Student Symposium took place on September 21, 2011, and included a special presentation by Dr. Kim Budil of Lawrence Livermore National Laboratory. It was the first joint U-M/Michigan State University MIPSE event. Thirty posters were presented by U-M students from the departments of EECS, Nuclear Engineering and Radiological Sciences, Aerospace Engineering, Atmospheric, Oceanic and Space Sciences, Mechanical Engineering, and Applied Physics, and 9 posters were presented by MSU students. Best Presentation Awards went to Iverson Bell (U-M), Shannon Demlow (MSU) and Peng Zhang (U-M).



Stephen Smith of Ecology and Evolutionary Biology speaks on the utility and use of huge phylogenies.

Third Annual Data Mining Workshop Brings Together 100+ Researchers

In what has become an annual event, over 100 researchers from across the University and from industry convened for the third *U-M Workshop on Data Mining* on April 18, 2012. Organized by Prof. Michael Cafarella and sponsored by CSE, Yahoo!, and the Office of Research Cyberinfrastructure, the day-long workshop brought together researchers currently using data mining or interested in the use of data mining to make connections. The workshop was followed by a CSE Distinguished Lecture by Michael Jordan of University of California, Berkeley entitled, “Statistics and Computation in the Age of Massive Data.” Follow the QR code to see videos from the workshop.

Exploring the Boundaries of Musical Expression

The *2012 New Interfaces for Musical Expression (NIME)* conference, chaired by Prof. Georg Essl, was held in Ann Arbor on May 21–23, 2012. NIME is an annual interdisciplinary conference discussing contemporary topics in electronic musical interface design, research, and practice. NIME brings together researchers and practitioners from a range of academic fields including computer science, electrical engineering, human-computer interaction, musicology, electro-acoustic music, dance and composition, and has routinely attracted interest from electronic music industry as well.

The conference included a series of concerts by composers and performers from around the world who played cutting-edge electronic music featuring augmented acoustic instruments, the rare Theremin Cello, brain-computer interfaces, mobile phones, musical robots, Theremins, as well as intriguing new digital instruments with names like Chirotron, Banshee, Fossil, and Sponge. Performances took place at the Mendelssohn Theatre and the Necto nightclub in downtown Ann Arbor. Lots of cool noise!

More News and Events

Distinguished Lectures

2011–2012 AY Distinguished Lectures in Computer Science and Engineering

BJARNE STROUSTRUP
Distinguished Professor and College of Engineering Endowed Chair
in Computer Science
Department of Computer Science
Texas A&M
"C++11 Style"
November 9, 2011

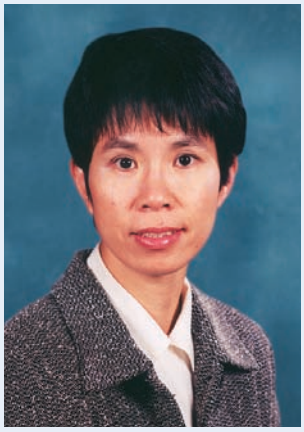
JIAWEI HAN
Bliss Professor of Computer Science
Department of Computer Science
University of Illinois at Urbana-Champaign
"Mining Heterogeneous Information Networks"
December 2, 2011

NANCY LYNCH
NEC Professor of Software Science & Engineering
Department of Electrical Engineering
and Computer Science
Massachusetts Institute of Technology
"Distributed Algorithms for Wireless Networks"
March 26, 2012

MICHAEL JORDAN
Pehong Chen Distinguished Professor
in the Department of Computer Science
and Department of Statistics
University of California, Berkeley
"Statistics and Computation in the Age of Massive Data"
April 18, 2012

Staff Awards

Dr. Dennis Grimard, Managing Director of the Lurie Nanofabrication Facility, received a 2012 U-M Work/Life Champion Awards for Supervisors.



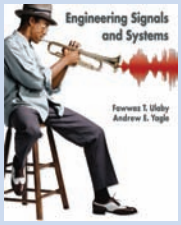
Prof. Stella Pang Retires

Stella Pang retired December 31, 2011, to become Professor Emeritus of the department. She is known for her contributions to the field of nanofabrication technology and the application of this technology to microelectromechanical, biomedical, microelectronic, and optical devices. She was a pioneer in the identification and removal of process induced damage in silicon and compound semiconductor devices and is a leader in advancing the science of nanofabrication technology.

Professor Pang was involved in international education through her collaborations with Asian universities and research laboratories in Hong Kong, mainland China, Japan, Singapore, and Korea. As Associate Dean of the College of Engineering from 2002–07, she played a key role in creating opportunities for student and faculty exchanges through the establishment of the University of Michigan-Shanghai Jiao Tong University Joint Institute.

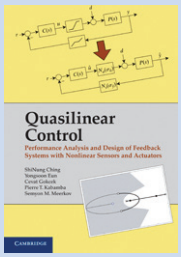
Professor Pang received her Sc.B. degree from Brown University in 1977, and her M.S.E. and Ph.D. degree from Princeton University in 1978 and 1981, respectively. She began her career as a research scientist in the submicrometer technology division of MIT's Lincoln Laboratories, and joined the University of Michigan in 1990 as an associate professor. She has published over 190 refereed technical papers, authored or edited 16 books or book chapters, received 9 patents, and contributed to scores of short courses, invited talks, and invited technical presentations at major technical conferences. She is a fellow of IEEE, the American Vacuum Society, and the Electrochemical Society.

NEW BOOKS



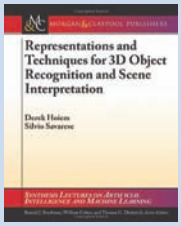
Engineering Signals and Systems is a new textbook authored by **Prof. Fawwaz Ulaby** and **Prof. Andrew Yagle** that is designed for undergraduate students enrolled in Michigan's course, EECS 216: Introduction to Signal and Systems, or similar courses. The book combines theory with applications, so that students learn to solve real world problems.

Prof. John E. Laird's new book, *The Soar Cognitive Architecture*, published by MIT Press, describes Soar, a general cognitive architecture that integrates knowledge-intensive reasoning, reactive execution, hierarchical reasoning, planning, and learning from experience to create a general computational system that has the same cognitive abilities as humans.

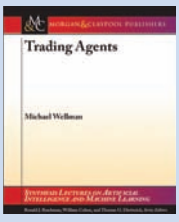


Prof. Semyon Meerkov co-authored the book, *Quasilinear Control: Performance Analysis and Design of Feedback Systems with Nonlinear Sensors and Actuators*, with former students Dr. ShiNung Ching, Dr. Yongsoon Eun, and Dr. Cevat Gokcek, and Prof. Pierre Kabamba (Aerospace Engineering and EECS).

Prof. Semyon Meerkov's book, *Production Systems Engineering*, co-authored by former student Dr. Jingshan Li, was translated into Chinese and published by Beijing Institute of Technology (August 2012).



Prof. Silvio Savarese co-authored the book *Representations and Techniques for 3D Object Recognition & Scene Interpretation* with Prof. Derek Hoiem (U. Illinois). The book is part of the series, *Synthesis Lectures on Artificial Intelligence and Machine Learning*, published by Morgan & Claypool Publishers.



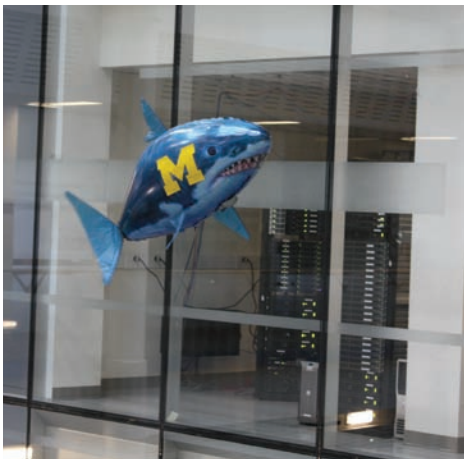
Prof. Michael P. Wellman's new book, *Trading Agents*, draws on key principles from research in economics and artificial intelligence and is written as a guide to the design and analysis of automated trading agents for electronic markets. The book is part of the series, *Synthesis Lectures on Artificial Intelligence and Machine Learning*, published by Morgan & Claypool Publishers.

Hackers Install "Bubbler" as Salute to Beysters

On the weekend of February 18, hackers struck the CSE building, installing a hot tub on the fourth floor balcony. Identified on an accompanying plaque as "The Bob and Betty Beyster Bubbler," the tub was apparently a nod toward the Beyster's gift of $15 million to the College, announced two days prior. Questions remain regarding the identities of the hackers and how they installed the tub — for it appeared too large to have fit though the narrow door that opened to its perch atop the building. But it's too late for close examination – three days later, the bubbler had vanished as mysteriously as it appeared.

Beware the Atrium Shark!

On November 9, 2011, those passing through Tishman Hall, the atrium in the CSE building, couldn't help but notice that the glass-lined, four-story atrium had a rather…. fishy feeling.



A floating blue shark, complete with a Block M, was trolling through this virtual aquarium, controlled by a remote that was passed from hand to hand. The shark made a later appearance at the conclusion of Bjarne Stroustrup's standing room only distinguished lecture, which capped things off nicely. Who says engineers don't know how to have fun?

Curriculum and Education News

Online Education

Coursera courses currently taught by EECS Faculty:

Computer Vision: From 3D Reconstruction to Visual Recognition, by Prof. Silvio Savarese and Prof. Fei Fei Li of Stanford University.

Securing Digital Democracy, by Prof. J. Alex Halderman.

University of Michigan faculty are venturing into the brave new world of free online courses through the education company called Coursera, founded in 2011. This makes U-M among the first world-class institutions to offer online courses at no charge.

Thriving in a Digital World

In Fall 2012, the department is offering its first computer science class for students not concentrating in Computer Science. EECS 101, **Thriving in a Digital World**, will be offered through the College of Literature, Science, and the Arts and will highlight the practical advantages of an understanding of computer science and the global effects of computing on our lives. Students will organize into groups during the course to develop mobile phone apps using a visual interface. Final projects will be showcased in a "demo day" at the end of the term.

LSA Students Can Now Select Tracks of Study in Computer Science

Beginning this fall, computer science students who enter the program through the College of Literature, Science, and the Arts will be able to tailor their study along one of nine "tracks" in Artificial Intelligence, Bioinformatics, Data and Information, Economics and Computation, Robotics and Vision, Security, Software Development, Software Systems, or Theory of Computation. Tracks are designed to help students to gain expertise in a specific area of interest; core program requirements for computer science through LSA and the College of Engineering remain identical.

Students Hack Autism in Two Computer Science Classes

Dr. David Chesney teaches programming, but also uses his classes to raise awareness of how engineering can be used for societal good. This year, the theme in both his ENG 100 and EECS 481 classes was "Gaming for the Greater Good," as students developed video games designed for use by individuals on the autistic spectrum.

ENG 100 is a freshman engineering course, and in Dr. Chesney's class students were introduced to programming fundamentals and organized into teams to use tools that allowed them to construct working PC-based video games. The extra twist to the class was that Dr. Chesney's students were able to visit Mott Children's Hospital and learn about the needs and challenges for individuals with autistic spectrum disorder. Dr. Chesney challenged his students to think of this audience when creating their projects. In the end, students produced 15 new games designed with the needs of autistic persons in mind.

Senior students in Dr. Chesney's Software Engineering class faced a similar challenge, but went through a more rigorous process of pitching project ideas to a panel of autism experts from Autism Speaks and Mott Hospital, and then creating a new class of games with a clear therapeutic focus using Microsoft Kinect hands-free technology. The final games have been installed at Mott for children to use. Sharif Moosa, a student in the class, said, "It was incredibly rewarding to see the children playing our games. It changed my perspective; I realized what I'm doing here could actually help people."

K-12 Outreach

Local Students See Science & Engineering in Action With MABEL, the Bipedal Robot

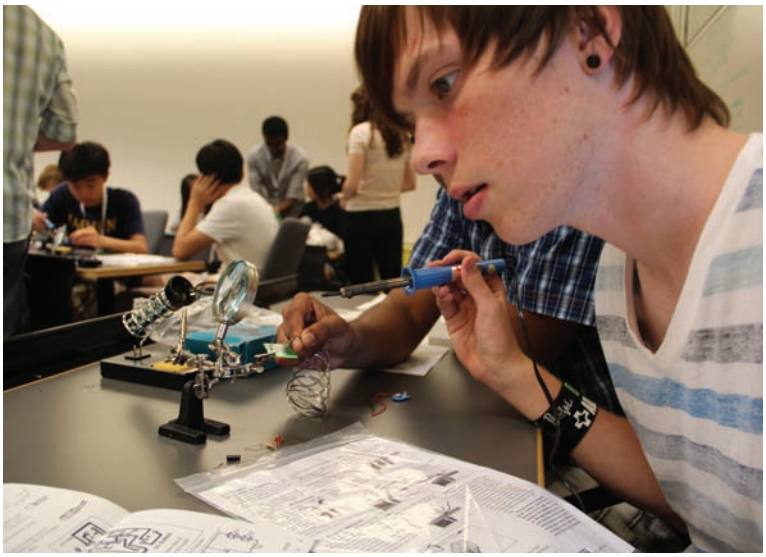
"There was more electricity in the air than the EECS building has seen in a while!" laughed Prof. Jessy Grizzle, Jerry W. and Carol L. Levin Professor of Engineering and principal architect behind the locomotion of the robot called MABEL. He was talking about the students visiting from the Michigan Technical Academy (MTA). MTA is a preK-8th grade school that serves children considered to be at high academic risk, with the goal of developing students who can compete on a global level. The 5th graders made sure MABEL's limbs were in working order. They discussed science with Prof. Grizzle ("yes, that's called gravity. And now we're talking physics"). They even borrowed MABEL's official Michigan football helmet.

Smaller is Better at NanoCamp 2012

Taking a break from processing their own gold-coated silicon wafers in the Lurie Nanofabrication Facility, local fourth graders played a tag team game where they had to dress in cleanroom garb before the relay race. Rounding the pole with their slippery booties proved to be the biggest challenge. More than 40 middle and high school students from SE Michigan were on campus to participate in NanoCamp 2012.

It's All About the Music

Over 40 rising Junior and Senior high school students from the Ann Arbor area rocked into CSE in June 2012 to explore computer science and engineering through the medium of music at a camp called, "It's All About the Music." Organized by the Office of Student Affairs, headed by Dr. David Chesney, and run in large part by current U-M engineering students, the camp provided an opportunity for students who are interested in music, digital media, technology, or the sciences to try out media-center content creation tools, build computer-related hardware projects, and explore career options, even if they didn't have experience in computer science. After its Ann Arbor launch, Dr. Chesney took the camp on the road to sites in Detroit, Grand Rapids, and Kalamazoo. Funding for the series of camps was provided by the Michigan Economic Development Corporation.



K-12 Outreach

Dragomir Radev Coaches High School Linguists to Multiple Wins in International Competition

Prof. Dragomir Radev has again led North American high school student teams to successful competition at the *10th International Linguistics Olympiad*, which was held in Ljubljana, Slovenia from July 29 to August 4, 2012. It is the sixth year that Radev has coached the team. The Olympiad mimics the skills used by experts to develop automated language technologies such as search engines and translation software.

In this year's individual contest, students had to solve problems about the languages Dyirbal, Umbu-Ungu, Basque, Teop, and Rotuman. In the team round, contestants were asked to decipher a list of 57 countries written in Lao. To solve these problems, the students applied knowledge about the way languages work as well as logic and reasoning skills to decipher unfamiliar languages and writing systems. The US teams once again turned in an extraordinary performance: US students won two gold, three silver, and one bronze medal in individual competition and one US team placed first in the team portion of the competition.

Jimmy Cao, center in yellow, coaching students from team 830 on the field.

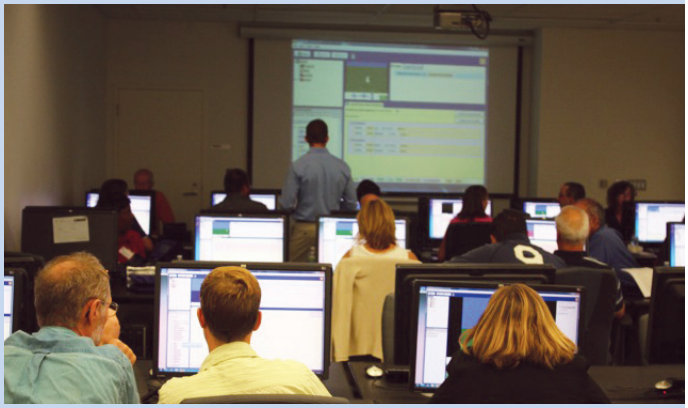
EECS Support and Student Mentors Help FIRST Robotics Achieve Success

EECS provided funding and donated six computers in support of FIRST Robotics of Michigan, which works to inspire local high school students to embark upon a career in engineering.

Nine U-M student mentors, including CS major Jimmy Cao, hosted a series of weekly hands-on workshops for the high students on topics including physics, computer-aided design, electrical wiring, programming, and systems design. They also worked with the students as they organized into four teams and developed Arduino-based robots to compete in statewide FIRST competitions. All four teams had success with their robots, reaching at least quarterfinals in competition, and one team, "830," became the Michigan state champions!

Summer Workshop for CS High School Teachers Plants Seeds, Grows in Popularity

Each summer, CSE holds CS4HS, a two-day workshop for high school teachers that is designed to help them to integrate principles of computing and computational thinking into their classrooms. CSE held its third and fourth CS4HS workshops, organized by Dr. Jeff Ringenberg, in August of 2011 and 2012. The 2011 workshop featured a keynote speech by Dr. Jan Cuny, National Science Foundation Program Officer for two programs, in computing and K-12 and a tour of the Ann Arbor Barracuda Networks facility. The 2012 workshop featured a keynote by CS alumnus Dug Song and a tour of local software development firm Menlo Innovations. Additional workshop activites included spotlights of successful local high school programs, hands-on technology lab sessions, and overviews of research at U-M. Feedback from teachers regarding the program has been very positive, and attendance for the CS4HS workshop has climbed from 20 teachers in 2009 to 60 teachers in 2012. The workshop is supported by Google.



Teachers in a lab session of the workshop learn to make video games.

New Faculty

LAURA BALZANO
Assistant Professor
PhD, Electrical and Computer Engineering University of Wisconsin, 2012

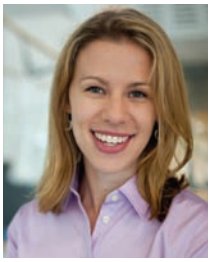
Laura studies computationally efficient and theoretically sound algorithms for detection, inference, and learning from massive data in modern signal processing applications. She is interested in applications such as computer network monitoring, environmental sensing, urban sensing, electronic medical records analysis, biological networks, social network mining, and collaborative filtering, in which data are often incomplete, corrupted, and an indirect indicator of the phenomenon of interest. Laura joins the faculty Winter term 2013.

KEVIN FU
Associate Professor
PhD, Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 2005

Kevin Fu will join the faculty in January 2013. His research is in the area of trustworthy computing and low-power embedded devices. In addition to systems security, RFID-scale computation, and energy-aware architectures, his interests include medical devices and health IT. He is currently Associate Professor of Computer Science at University of Massachusetts Amherst, where he is Lab Director for the Security and Privacy Research Lab. Prof. Fu has served as a visiting scientist at the Food & Drug Administration, the Beth Israel Deaconess Medical Center of Harvard Medical School, and MIT CSAIL, and is a member of the NIST Information Security and Privacy Advisory Board. Prof. Fu is the recipient of a Sloan Research Fellowship, the NSF CAREER award, and best paper awards from USENIX Security, IEEE S&P, and ACM SIGCOMM. He was named MIT Technology Review's TR35 Innovator of the Year in 2009, and is a Senior Member of the Association for Computing Machinery.

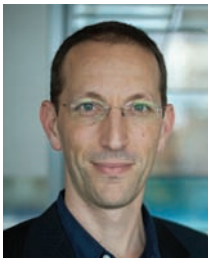
GRANT SCHOENEBECK
Assistant Professor
PhD, Computer Science, University of California, Berkeley, 2010

Grant Schoenebeck joined the faculty in September 2012 from Princeton University, where he was a Simons Foundation Postdoctoral Research Fellow in Theoretical Computer Science. Dr. Schoenebeck has broad interests in theoretical computer science, and his research includes work on using linear and semidefinite programs to approximate NP-complete optimization problems, and computational complexity theory. He is particularly interested in the intersections of computer science with social networks and economics. He applies theoretical computer science approaches to help understand network formation, social network structure, and processes over social networks (such as consensus, information aggregation, and games over networks). Dr. Schoenebeck offers a number of exciting opportunities for expanding Michigan's research programs in theoretical computer science.



EMILY MOWER PROVOST
Assistant Professor
PhD, Electrical Engineering, University of Southern California, 2010

Emily Mower Provost joined the faculty in January 2012. Her research is in the area of human-centered signals and systems, where she focuses on the analysis of human behavior, leveraging techniques from the fields of signal processing, machine learning, and statistics. Emily seeks to provide a computational account of how humans perceive emotional utterances ("emotion perception") and combine this with knowledge gleaned from perception estimation studies ("emotion recognition") to develop a system capable of interpreting naturalistic expressions of emotion utilizing a new quantification measure ("emotion profiles") for application in the design of human-centered assistive devices.



SHAI REVZEN
Assistant Professor
PhD, Biomechanics, UC-Berkeley, 2009

Since graduating from UC-Berkeley, Shai has been affiliated with the General Robotics, Automation, Sensing and Perception (GRASP) Lab at the University of Pennsylvania. His research activities include experimental biology, experimental robotics, robotic theory and applied mathematics. More specifically, his research focuses on the role of mechanical dynamics in the control of animal and robot motion. He has already made an impact in extending bio-inspired mechanical ideas toward modular robotics. His first course at the University of Michigan will be "Hands on Robotics," for senior undergraduate and graduate students. Shai joins the faculty Fall term 2012.

Leaders and Best

NSF CAREER and Young Investigator Awards

MONA JARRAHI

2012 Office of Naval Research (ONR) Young Investigator Award

"Plasmonics-enabled Material Characterization at the Nanoscale." In this project, Prof. Jarrahi will conduct fundamental physical studies on the ultrafast dynamics of carriers in semiconductor nanostructures.

2012 Army Research Office (ARO) Young Investigator Award

"Fundamental Properties and Capabilities of Plasmonic Antennas for Efficient Interaction with Nanoelectronics." In this project, she will conduct fundamental studies on unique properties of plasmonic antennas to mitigate efficiency degradation of conventional antennas interacting with nanoelectronics at terahertz and optical frequencies.

RAJ NADAKUDITI

2012 Air Force Office of Scientific Research (AFOSR) Young Investigator Award

"Random matrix theoretic approaches to sensor fusion for sensing and surveillance in highly cluttered environments." In this project, Prof. Nadakuditi plans to provide an analytical characterization of the fundamental limits of multi-modal sensing of weak signals, and develop algorithms to improve the sensing capability of today's sensors.

SATISH NARAYANASAMY

2012 NSF CAREER Award

"Holistic System Solutions for Empowering Parallel Programmers." This project aims to bring parallel programming, which continues to be a daunting task to this day even for experts, to mainstream programmers and includes potential solutions that span from processors to languages.

ZEESHAN SYED

DARPA Young Faculty Award

"Computational Neuromarkers." This project aims to discover novel markers for screening mental health conditions such as bipolar disorder and schizophrenia using sophisticated computation to extract information in physiological signals that is often difficult to visualize directly.

Fawwaz Ulaby

Emmett Leith Distinguished University Professor of Electrical Engineering and Computer Science

IEEE James H. Mulligan Education Medal

Prof. Ulaby received the IEEE James H. Mulligan Education Medal, "for contributions to undergraduate and graduate engineering education through innovative textbooks, dedicated mentoring of students, and inspirational teaching." The medals are the most prestigious of the awards bestowed by IEEE.

Few faculty can teach a large undergraduate course of highly technical subject matter and receive perfect scores from the students. Prof. Ulaby accomplished this goal after completely revising two large mandatory undergraduate courses and their accompanying labs. In support of these courses he wrote the textbook *Applied Electromagnetics*, now in its 6th printing and adopted by literally hundreds of engineering departments around the world. His textbook, *Circuits*, published in 2009 and co-authored by Prof. Michel Maharbiz, is being used at many of the top engineering institutions in the country, and earlier this year he co-authored the textbook *Signals and Systems* with Prof. Andy Yagle.

His teaching awards range from the student-nominated HKN Professor of the Year Award, to the U-M Thurnau Professorship, and the national HKN C. Holmes MacDonald Outstanding Teaching Award. In addition to his contributions to education, his extensive leadership in the professional and academic community combined with his research excellence led to many awards, including membership in the National Academy of Engineering.

Faculty Honors and Awards

EECS Awards

SATINDER SINGH BAVEJA
Outstanding Achievement Award for innovative research in reinforcement learning, developing new undergraduate courses in machine learning and computational art, and for leading the CSE search committee and the Artificial Intelligence Laboratory.

IAN HISKENS
Vennema Professor of Engineering

Outstanding Achievement Award for leadership in re-establishing research and education in the areas of electric power systems, electric machines, and power electronics in the EECS Department; for developing new courses in power and energy systems; and for innovative research on the stability and control of electrical power systems.

DENNIS SYLVESTER
Outstanding Achievement Award for innovative research in millimeter-scale, energy-efficient integrated circuits; for leadership in the establishment of the Michigan Integrated Circuits Laboratory (MICL); and for sustained excellence in teaching and curriculum development in integrated circuits and VLSI.

College of Engineering Awards

JASON FLINN
Education Excellence Award

TED NORRIS
Research Excellence Award

JEFF RINGENBERG
Thomas M. Sawyer, Jr. Teaching Award

For educational excellence by non tenure-track faculty.

KIM WINICK
Service Excellence Award

HKN Professor of the Year

MARK BREHOB
Based on student input, Dr. Brehob was selected as the 2011–2012 HKN Professor of the Year by the U-M chapter of Eta Kappa Nu.

University Awards

JEFF FESSLER
Distinguished Graduate Mentor Award

For sustained efforts as advisor, teacher, advocate, sponsor, and role model to doctoral students.

National and Professional Honors and Awards

VALERIA BERTACCO
Prof. Bertacco received the Early Career Award from the IEEE Council on Electronic Design Automation for her outstanding contributions in the area of hardware verification, including her work on semi-formal verification, runtime and post-silicon verification, and correctness-constrained execution. She was also awarded an IBM Faculty Award for her work in design correctness, full design validation, digital system reliability, and hardware security assurance.

THEODORE BIRDSALL
Professor Emeritus Ted Birdsall received the Silver Medal in Signal Processing in Acoustics by the Acoustical Society of America, “for contributions to signal detection theory and development of coded sequences in underwater acoustics.” He is the second recipient of this award.

DAVID BLAAUW
Prof. Blaauw was named Fellow of the IEEE “for contributions to adaptive and low-power circuit design.”

Faculty Honors + Awards

National and Professional Honors and Awards cont.

EDMUND DURFEE
Prof. Durfee received an Outstanding Achievement in Research Alumni Award from the University of Massachusetts Computer Science Department for his work in the areas of distributed artificial intelligence, multi-agent coordination, and intelligent real-time systems.

JESSY GRIZZLE, Jerry W. and Carol L. Levin Professor of Engineering
Prof. Grizzle received the 2012 Hendrik W. Bode Lecture Prize of the IEEE Control Systems Society, which recognizes distinguished contributions to control systems science and engineering. He will deliver the plenary Bode Lecture at the *2012 IEEE Annual Conference on Decision and Control (CDC).*

GEORGE HADDAD, Robert J. Hiller Professor Emeritus of Electrical Engineering and Computer Science
Prof. Haddad received the IEEE Microwave Theory and Techniques Society (MTT-S) Microwave Career Award. This is the most prestigious award bestowed by the MTT Society, and recognizes "a career of meritorious achievement and outstanding technical contribution by an individual in the field of microwave theory and techniques."

H.V. JAGADISH, Bernard A. Galler Collegiate Professor of Electrical Engineering and Computer Science
Prof. Jagadish was re-elected to a three-year term on the Computing Research Association (CRA) Board of Directors.

HONGLAK LEE
Prof. Lee was awarded a Google Faculty Research Award for his work in machine learning and its application to a range of perception problems in artificial intelligence.

JOHN E. LAIRD, John L. Tishman Professor of Engineering
Prof. Laird has been named a Fellow of the American Association for the Advancement of Science (AAAS) for his contributions to science and technology.

IGOR MARKOV
Prof. Markov was named ACM Distinguished Scientist for his research in the areas of computer architecture, CAD and VLSI, and quantum science and devices. In addition, Prof. Markov and Andrew Kahng (UCSD) won the A. Richard Newton GSRC Industrial Impact Award for their research on VLSI circuit placement and the software package called Capo, used by academic groups and companies worldwide.

MARTHA POLLACK
Prof. Pollack has been named a Fellow of the American Association for the Advancement of Science (AAAS) for her contributions to science and technology. She was also named a Fellow of the Association for Computing Machinery (ACM) "for contributions to planning systems design and for service to the computing community."

MINA RAIS-ZADEH
Prof. Rais-Zadeh received the 2011 EDS Early Career Award, presented to an outstanding IEEE Electron Devices Society Graduate of the Last Decade (GOLD) member. She also received a grant in this inaugural year of the NASA Space Technology Research Opportunities for Early Career Faculty program for her project, "Chip-Scale Precision Timing Unit for PicoSatellites."

ELLIOT SOLOWAY, Arthur F. Thurnau Professor
Prof. Soloway received the 2012 AECT Distinguished Development Award from the Association for Educational Communications and Technology for his work in technology-based curricula for K-12 education and for his vision in advocating for the use of mobile computing for learning. Prof. Soloway was also recognized with an Outstanding Contributions to Society Alumni Award from the University of Massachusetts Computer Science Department for his work in developing technology-based curricula and mobile computing for learning tools.

Faculty and Student Outstanding Paper Awards*

"A Compact Very Low Phase-noise Voltage-controlled-oscillator at X-band," by **Morteza Nick** and **Prof. Amir Mortazawi**, Best Paper Award, *2011 International Microwave Symposium.*

"A Market-Oriented Programming Environment and its Application to Distributed Multicommodity Flow Problems," by **Prof. Michael P. Wellman**, 2012 International Foundation of Autonomous Agents and Multi-Agent Systems Influential Paper Award. Originally published in the *Journal of Artificial Intelligence Research* in 1993.

"Anomaly Detection Without a Pre-Existing Formal Model: Application to an Industrial Manufacturing System," by **John Broderick, Lindsay Allen**, and **Prof. Dawn Tilbury** (professor of Mechanical Engineering and ECE), Best Application Paper Award, *2011 IEEE International Conference on Automation Science and Engineering (CASE).*

"A Resilient Condition Assessment Monitoring System," by **H.E. Garcia, W.-C. Lin**, and **Prof. Semyon M. Meerkov**, Best Symposium Paper Award, 5*th International Symposium on Resilient Control Systems (ISRCS 2012).*

"BigHouse: A Simulation Infrastructure for Data Center Systems," by **David Meisner, Junjie Wu**, and **Prof. Thomas F. Wenisch**, Best Paper Award, *2012 IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS-2012).*

"Computational Sprinting," by **Arun Raghavan**, **Yixin Luo**, **Anuj Chandawalla**, **Prof. Marios Papaefthymiou**, **Prof. Kevin P. Pipe**, Professor of Mechanical Engineering and ECE, **Prof. Thomas F. Wenisch**, and **Milo M. K. Martin**, Best Paper Award, *18th International Symposium on High Performance Computer Architecture (HPCA).*

"Distilling Critical Attack Graph Surface iteratively through Minimum-Cost SAT Solving," by **Heqing Huang**, **Su Zhang**, **Xinming Ou**, **Prof. Atul Prakash**, and **Prof. Karem Sakallah**, Best Paper Award, *2011 Annual Computer Security Applications Conference (ACSAC '11).*

"E-MiLi: Energy Minimizing Idle Listening in Wireless Networks," by **Xinyu Zhang** and **Prof. Kang G. Shin**, Best Paper Award, *17th ACM Annual International Conference on Mobile Computing and Networking (MobiCom).*

"Graph Symmetry Detection and Canonical Labeling: Differences and Synergies," by **Hadi Katebi**, **Prof. Karem A. Sakallah**, and **Prof. Igor L. Markov**, Best Paper Award, *The Alan Turing Centenary Conference.*

"In-Situ Soil Moisture Sensing: Measurement Scheduling and Estimation using Compressive Sensing," by **Prof. Mingyan Liu** and **Xiaopei Wu** (a visiting student at the time), Best Paper, *11th ACM/IEEE Conference on Information Processing in Sensor Networks (IPSN).*

"Look Who I Found: Understanding the Effects of Sharing Curated Friend Groups," by **Lujun Fang**, **Alex Fabrikant**, **and Prof. Kristen LeFevre**, Best Student Paper Award (Computer Science), *ACM Web Science Conference 2012.*

"Maestro: Quality-of-Service in Large Disk Arrays," by **Arif Merchant**, **Mustafa Uysal**, **Pradeep Padala**, **Xiaoyun Zhu**, **Sharad Singhal**, and **Prof. Kang Shin**, Best Paper Award, *8th IEEE International Conference on Autonomic Computation (ICAC).*

"MBE Grown Single Element HgCdTe nBn Infrared Detectors," by **Anne Itsuno**, **Dr. Silviu Velicu**, and **Prof. Jamie Phillips**, **William E. Spicer** – Thomas N. Casselman Award for Best Student Paper, *2011 U.S. Workshop on the Physics and Chemistry of II-VI Materials.*

"Mining Your Ps and Qs: Detection of Widespread Weak Keys in Network Devices," by **Nadia Heninger**, **Zakir Durumeric**, **Eric Wustrow**, and **J. Alex Haderman**, Best Paper Award, *21st USENIX Security Symposium.*

"On Evaluating the Performability of Degradeable Computing Systems," by **Prof. Emeritus John F. Meyer**, 2012 IFIP Jean-Claude Laprie Award in Dependable Computing.Originally published in *IEEE Transactions on Computers* in 1980.

"Plasmonic Nanostructures for Transparent Photovoltaic Facades," by **Brian Roberts, Nanditha Dissanayake**, and **Prof. P.-C. Ku**, Best Poster, *37th IEEE Photovoltaic Specialist Conference.*

"Resilient Monitoring System: Design and Performance Analysis," by **Humberto Garcia** (Idaho National Laboratory), **Naman Jhamaria** and **Heng Kuang**, **Wen-Chiao Lin** (MSE PhD EE:Systems, Idaho National Laboratory), and **Prof. Semyon M. Meerkov**, Best Track Paper Award, *2011 International Symposium on Resilient Control Systems.*

"Sample Eigenvalue Based Detection of High-Dimensional Signals in White Noise Using Relatively Few Samples," by **Prof. Raj Nadakuditi** and **Dr. Alan Edelman**, published in the *IEEE Transactions on Signal Processing*, vol. 56, no. 7, July 2008. **Prof. Nadakuditi**, 2012 IEEE SPS (Signal Processing Society) Young Author Best Paper Award.

"Semantic Structure from Motion with Object and Point Interactions," by **Sid Bao**, **Mohit Bagra**, and **Prof. Silvio Savarese**, Best Student Paper, *1st IEEE Workshop on Challenges and Opportunities in Robot Perception.*

"The Mobile Participation System: Not Just Another Clicker," by **Marcial Lapp**, **Dr. Jeff Ringenberg**, undergrads **Kyle J. Summers** and **Ari S. Chivukula**, and **Jeff Fleszar** (Ross School of Business), John A. Curtis Lecture Award for the Best Paper in Computers in Education Division, *18th American Society for Engineering Education Annual Conference (ASEE).*

"Thermal Emission in Type-II GaSb/GaAs Quantum Dots and Prospects for Intermediate Band Solar Energy Conversion," by **Jinyoung Hwang**, **Andrew Martin**, **Joanna Millunchick**, and **Prof. Jamie Phillips**, Best Poster Award, *2011 Materials Research Society Fall Meeting.*

"Transfer Learning for Automatic Gating of Flow Cytometry Data," by **Gyemin Lee**, **Dr. Lloyd Stoolman**, and **Prof. Clayton Scott**, Pascal2 Best Student Paper Award, *28th International Conference on Machine Learning (ICML 2011) Workshop on Unsupervised and Transfer Learning.*

"Vector Electromagnetic Scattering From Layered Rough Surfaces With Buried Discrete Random Media for Subsurface and Root-zone Soil Moisture Sensing," by **Xueyang Duan** and **Prof. Mahta Moghaddam**, First Prize in the Student Paper Contest, *2011 IEEE Geoscience and Remote Sensing Symposium (IGARSS).*

*Names in **bold** are U-M faculty or graduate students, unless otherwise identified.

Tech Transfer

With a focus on startup companies spun-off from technology developed by faculty and students in the EECS Department.

Arborlight LLC Partners With Architectural Firm

Arborlight LLC, co-founded by Prof. P.C. Ku and Prof. Max Shtein (Materials Science and Engineering) in 2010, has partnered with Duo-Gard Industries to develop light-emitting diode (LED) lighting integration techniques to advance architectural illumination. Arborlight develops LED lighting alternatives to fluorescent tubes, which are replaced in numbers exceeding hundreds of millions each year. By switching to their LED tubes, the company believes it could eliminate more than five metric tons of mercury annually that would otherwise be generated during the processing of fluorescent tubes.

2 EECS Startups in Latest EE Times List of 50 Emerging Startups

Ambiq Micro, Inc. appears again, and Cyclos Semiconductor, Inc. joins *EE Times'* list of 60 emerging startup companies featured in its annual publication, *Silicon 60*, version 13.0.

ePack
solving MEMS packaging

ePack Receives Manufacturing Award

ePack, Inc. received the Masco Next Gen Manufacturing Award at the second annual Accelerate Michigan Innovation Competition, held November 15–17, 2011. The company specializes in MEMS packaging solutions. ePack was co-founded by Prof. Khalil Najafi and three individuals formerly associated with the NSF Center for Wireless Integrated MicroSystems (now WIMS^2), Dr. Jay Mitchell, Dr. Sang Woo Lee, and Joe Giachino.

PiCoCAL

PicoCal Receives Small Company Innovation Grant

PicoCal received a Small Company Innovation Program (SCIP) grant to support research aimed at improving the manufacturing process of nano-structured materials and nano devices. The company, co-founded by Prof. Yogesh Gianchandani, develops micro-machined sensors and actuators for semiconductor, nanotechnology, material characterization, and biological applications. The award marks the beginning of a collaborative effort among six public universities working to connect businesses with university resources, and is funded by the Michigan Economic Development Corp.

Crossbar

Michigan Investment in New Technology Startups (MINTS) Program Supports Crossbar

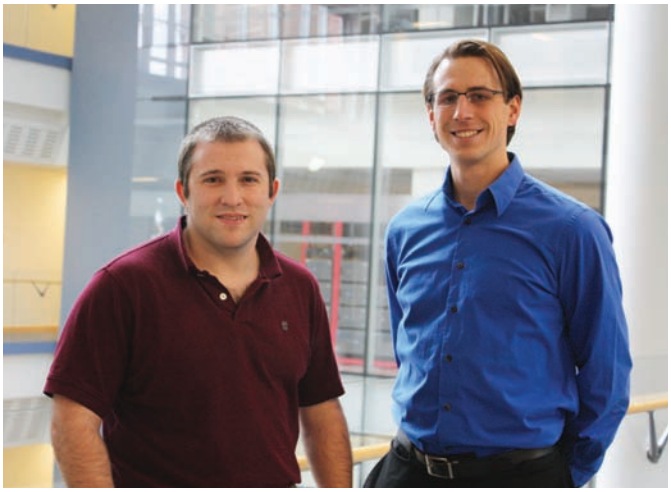
Crossbar, Inc., co-founded by Prof. Wei Lu, was the first recipient of a new University initiative called the Michigan Investment in New Technology Startups (MINTS) program, created to assist promising startup companies from Michigan. Crossbar, an advanced memory development company based in Santa Clara, CA, is developing a new nonvolatile memory technology that will offer unprecedented density and power improvements in tomorrow's electronics.

Technology to Optimize Battery Performance is Transferred to Commercial Sector

Kang Shin, Nancy and Kevin O'Connor Professor of Computer Science, and CSE Research Fellow Hahnsang Kim founded Advanced Battery Control (ABC) in 2010 to commercialize energy efficiency technology for large-scale battery applications including various types of electric vehicles, battery-powered robots, and uninterruptible power supplies (UPS) for power grids. The U-M Office of Technology Transfer has exclusively licensed their Dependable Efficient Scalable Architecture (DESA) and three associated pending patents to Michigan-based energy control system company Spider 9. DESA is designed to radically enhance lithium ion battery functionality and utilization in tomorrow's $12 billion hybrid and all-electric vehicle market. DESA uses a proprietary software algorithm, reconfigurable hardware array, and scalable system architecture to potentially cut in half the cost and size of electric vehicle battery packs. Spider 9 is pursuing a number of potential uses for the technology.

ASK Interfaces Wins Recognition, Cash, in Competitions

ASK Interfaces, which began as a student project in Dr. David Chesney's EECS 481 Software Engineering course, has evolved into a commercial entity — and gained additional notoriety along the way. In November 2011, the original team of student developers won the Student of da Vinci Award for its mobile app, which enables individuals with fine motor disabilities to successfully navigate an iPad and send messages. In February 2012, CS undergrad Chris McMeeking partnered with alum Jeff Miller (BSE CS 2003) and U-M business school alum Jackson Buell to formalize a company around the product. McMeeking won $100,000 of funding for the new venture in the Facebook-based Intel Innovators competition for his business plan presentation of an Android version of the product.



Chris McMeeking and Jeff Miller of ASK Interfaces.

Cyclos Energy-Recycling Technology Increases Efficiency of New Generation of Processors

Cyclos Semiconductor, the resonant clock-mesh technology company co-founded and headed by CSE Chair Marios Papefthymiou, has seen its technology taken up by global semiconductor manufacturer Advanced Micro Devices (AMD) as a key enabler in their new "Piledriver" line of multi-core processors. Cyclos' technology allowed AMD to reduce the total power consumption of the processor core by about 10 percent by recycling the electric charge that conventional clock designs would otherwise dissipate as heat, allowing for increased density. Cyclos recycles energy by adding inductors to a processor that store energy in magnetic fields and couples those inductors with existing capacitors that store energy in electric fields to create highly efficient "tank circuits." Tank circuits act like pendulums, swinging energy back and forth between the electric and the magnetic fields so that it may be re-used. AMD's use of Cyclos' technology in the Piledriver is the first large-volume commercial deployment of a resonant clock technology, and the chips are now in use in laptops from HP, Samsung, and other manufacturers. Cyclos has offices in Ann Arbor and Berkeley, CA, and was founded in 2006 through the Office of Technology Transfer.

Special Feature

Kensall D. Wise: Michigan, MEMS and Microsystems

A Big Career from Small Things

William G. Dow Distinguished University Professor Emeritus of Electrical Engineering and Computer Science

Kensall D. Wise, William G. Dow Distinguished University Professor Emeritus of Electrical Engineering and Computer Science, officially retired in June, 2011, though he continues to participate in ongoing research projects - giving his colleagues hope that he will never truly retire.

When Ken came to the University of Michigan from Bell Labs in 1974, he envisioned working with students and colleagues to expand his doctoral research in the use of silicon micromachining for neural probes. As the first hire in his field, the challenges were enormous – but Michigan now had Ken, and Michigan became Ken's playground.

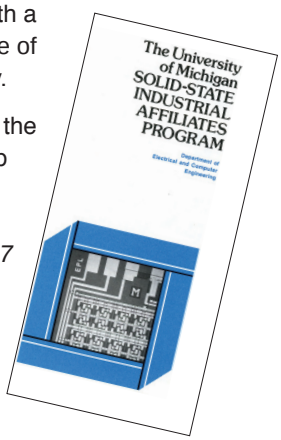
With his unique combination of boundless enthusiasm, inventiveness, practicality, focus on teamwork and education, and dogged determination, he built a world-class program in MEMS (MicroElectroMechanical Systems) and microsystems that is supported by one of the top nanofabrication facilities in the nation.

The Early Years

When Ken arrived at Michigan, he was convinced that using semiconductor/silicon technology to make sensors was going to be big. In the early years, the research laboratory was sufficient for Ken to begin to build his program.

"Sensors were a good match for our early lab in East Engineering," recalled Ken. "They were in their formative stage, so the research didn't require a lot of high tech equipment. Also, Michigan's a great place to do the interdisciplinary work required of sensor research."

Ken recalls working with Dr. Mark Orringer in the Medical School on an esophageal catheter. He marveled that as an assistant professor he was able to collaborate with a brilliant surgeon who would become one of the top thoracic surgeons in the country.



By 1976, he created what was perhaps the first silicon pressure sensor with on-chip readout circuitry. It was also the first micromachined sensor developed at Michigan. *[see the timeline on pp. 44–47 for research highlights throughout his career]*

When he became Director of the Electron Physics Laboratory (later renamed the Solid-State Electronics Laboratory) in 1979, one of the first things he did was to initiate an industrial affiliates program. This program helped raise awareness of the lab's research among industry.

80's – 90's: A New Lab - A New Discipline (MEMS)

Ken was reaching a wall in what could be accomplished with the current facilities by the late 70's. Some new and used equipment was added which helped, but more important was the arrival of Jim Duderstadt as the new Dean of the College of Engineering in 1981. Duderstadt worked with the State of Michigan to fund a new building that included a true cleanroom facility on North Campus (the existing lab was on Central Campus).

"The new lab was absolutely pivotal to our future work in Solid State and MEMS. Without it, none of our later successes would have been possible," said Prof. Wise. He formed the Center for Integrated Sensors and Circuits in 1987, the same year the new cleanroom became operational, and began assembling a team of faculty working in this area thanks to several faculty hires in the 80's and 90's. Things were definitely starting to look up.

MEMS

MEMS are composed of tiny sensors, actuators, and micromachines and have tremendous marketplace potential. Their use in mobile phones alone is expected to generate annual revenues in excess of $5B by 2017. They are used for precise sensing of the environment, for monitoring infrastructure integrity, and for both diagnosing and treating a variety of health issues. They control the cars we drive and the airplanes we fly. Ranging from a few millionths to several thousandths of a meter in size, MEMS devices are often combined on a single chip with microelectronic circuits to become complete microsystems.

The Solid-State Electronics Laboratory was completed as part of the new EECS building in 1986, and equipped during the following year.

MEMS was coalescing as a distinct discipline in the early 80's, marked by newly-formed conferences in the field. Prof. Wise and his colleagues were heavy players early on in the *Transducers* conference, which was initiated in 1981, and he was instrumental in establishing the *Solid-State Sensors, Actuators and Microsystems Workshop*, first held in 1984.

"Those were years in which the field was taking shape," recalled Ken. "We were doing pioneering work with the goal of being the world's center for MEMS." This work included groundbreaking research in neural probes, flowmeters, gas sensors, pressure sensors, infrared detectors, and other MEMS devices.

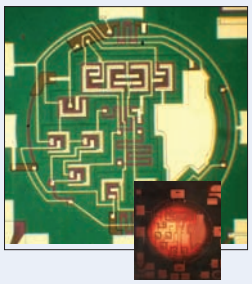
The research was enabled by key long-term programs funded by government and industry. One of these programs, funded by the National Institute of Neurological Disorders and Stroke (NINDS), enabled research in neural probes between 1981 and 2006. Another was the Program in Automated Semiconductor Manufacturing, funded by the Semiconductor Research Corporation (SRC) between 1984 and 1998.

The SRC program became a Center of Excellence, and resulted in novel techniques and devices important to the entire semiconductor manufacturing industry. The neural probe research was so wide-ranging, the devices came to be known simply as the "Michigan Probes." In the following decade, these probes were distributed around the world to research groups, and are currently being used to explore treatments for epilepsy, Parkinson's Disease, deafness, paralysis, and other disorders.

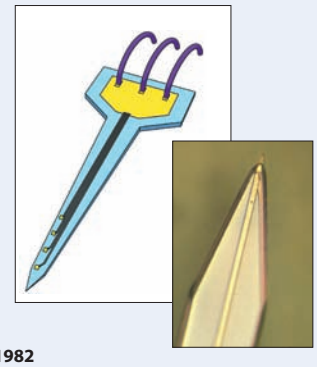
When DARPA formed its MEMS activities in the early 1990's, one of the first programs funded was a project proposed by Prof. Wise and his former student-turned-colleague Khalil Najafi (Schlumberger Professor of Engineering and ECE Chair). Their plan was to develop a wristwatch-sized device that combined sensors and a microprocessor, and importantly, that was also wireless. Prof. Wise suffered a heart attack during the proposal process, yet amazingly this dynamic team moved ahead seemingly at full steam.

Throughout the 1990's, Ken's research became increasingly interdisciplinary as the technology and the lab supported the creation of complete integrated microsystems. In 1998, he changed the name of his center to the Center for Integrated MicroSystems.

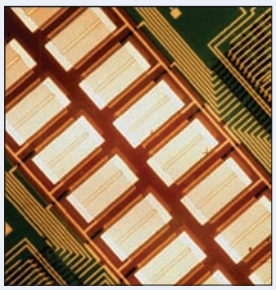
(Continued on page 48)



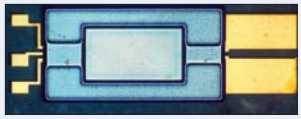
1976
One of the earliest, if not the first, silicon pressure sensor with on-chip readout circuitry, and the first micromachined sensor developed at Michigan (reported in the 1979 ISSCC award-winning paper).



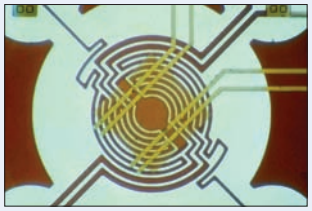
1982
Probes designed to record the activity of neurons in the central nervous system demonstrated the first practical process for building a high-density microelectronic interface to the cellular world.



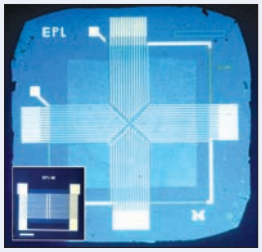
1985
Uncooled thermopile imaging array with on-chip electronics – later commercialized.



1985
World's smallest pressure sensor, a silicon-on-glass structure realized with the dissolved wafer process, capable of measuring blood pressure within the coronary arteries.

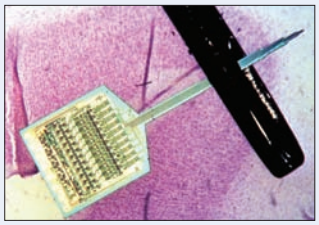


1988
World's first conductivity-based "microhotplate" gas detector.

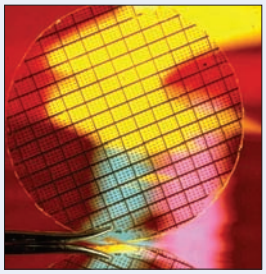


1980
First silicon micromachined uncooled infrared detector. This technology is now found in commercial products, such as appliances, security systems, ear thermometers, and radiometry.

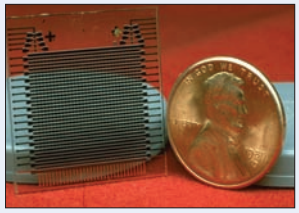
1982
SENSIM, one of the first sensor CAD programs, was developed to analyze performance of newly created silicon capacitive pressure sensors.



1985
First neural probe integrated with on-chip readout circuitry (reported in the 1986 *ISSCC* award-winning paper).



1987
The first high-performance transistors were realized in this silicon-on-glass process, intended for use with LCD displays.



1989
This 1024-element silicon capacitive tactile imager was the largest ever reported (reported in 1990 EDS award-winning paper).

1981-2006 — Director of continuously-funded programs from the NIH/NINDS

1979-1987 — Director, Solid-State Electronics Laboratory (called the Electron Physics Lab until 1984)

1960 1970 M 1980

1963 Purdue University, BS EE
1963-1966 Bell Telephone Laboratories (Murray Hill, NJ)
1964 Stanford University, MSEE
1965-1969 Stanford University, PhD EE
1969-1972 Research Associate and Lecturer, Stanford University
1972-1974 Bell Telephone Laboratories (Naperville, IL)
1974-1978 Assistant Professor, Michigan

1974
The Electron Physics Laboratory in East Engineering. In those days, coats were worn to keep the clothing clean rather than to protect the devices being made.

1978-1982 Associate Professor, Michigan
1979 Guest Editor, *IEEE Trans ED* and *JSSC*

1980
By 1980, support had been found to expand and improve the lab. It was an important step forward.

1981-85 Associate Editor, *IEEE Transactions on Electron Devices*
1981-99 Member, International Steering Committee for Solid-State Sensors
1982 Professor, Michigan
1982 Guest Editor, *IEEE Trans ED*
1984 General Chair, *IEEE Solid-State Sensor Conference, Hilton Head*
1985 Program Chair, *IEEE International Conference on Solid-State Sensors and Actuators (Transducers)*

1986
The EECS Building was dedicated, complete with the new Solid-State Electronics Laboratory. The new cleanroom facility enabled continuing advances in MEMS, microsystems, and other devices.

1971
ISSCC Outstanding Paper Award
"A microprobe with integrated amplifiers for neurophysiology," by K. D. Wise and J. B. Angell

1974
NASA Certificate of Recognition for Creative Development of Technology, (Microminiature Gas Chromatograph)

1976
1938E Award (CoE)

1978
Distinguished Service Award (U-M)

1979
ISSCC Outstanding Paper Award, "Integrated Signal Conditioning for Diaphragm Pressure Sensors," by J. M. Borky and K. D. Wise.

1986
ISSCC Beatrice Winner Award, "An Implantable Multielectrode Array with On-Chip Signal Processing," by K. Najafi, K.D. Wise.

IEEE Fellow, "for leadership in the field of integrated solid-state sensors and engineering education"

IEEE EDS National Lecturer

1987
NASA Certificate of Recognition for the Innovative Development of Technology (Integrated Gas Flow Controller)

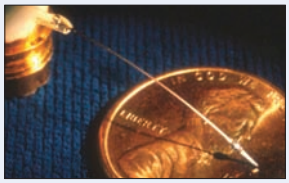
Students

1977 John Michael Borky
1980 Thomas Nelson Jackson
1981 Gholamhassan Roientan Lahiji
Yong Surk Lee
Sea-Chung Kim

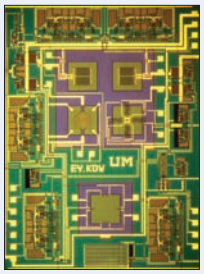
1982 Chang-Lee Chen
Ki Won Lee
1983 John Edward Bertsch
Jammy Chin-Ming Huang
Yong Eue Park

1986 Kukjin Chun
Il Hyun Choi
Khalil Najafi

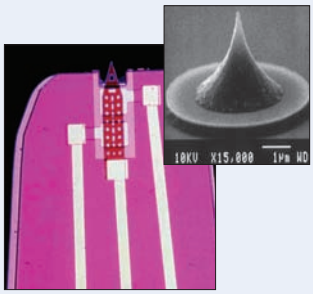
1987 Kenneth Lloyd Drake
Hin-Leung Chau
1988 Leland Joseph Spangler



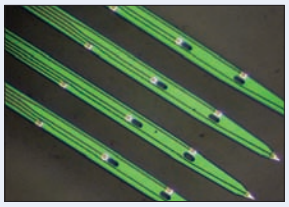
1989
These silicon ultra-flexible cables were the first to successfully interface with chronically-implanted biomedical sensors with negligible leakage and tethering. They were a key element in allowing MEMS-based sensors to operate in harsh environments.



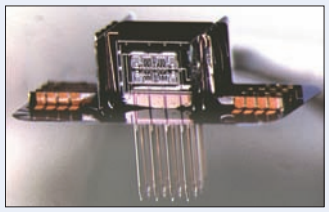
1990
This CMOS micro-flowmeter containing sensors for pressure, temperature, gas type, flow rate, and flow direction with readout electronics was the first of its kind.



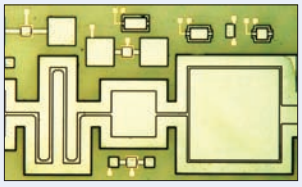
1993
An integrated force microscope with an iridium-coated polysilicon tip pioneers machine vision for semiconductor process control.



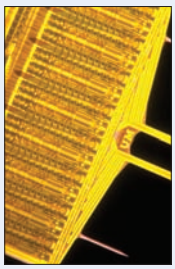
1996
Multi-channel "Michigan Probes" are distributed worldwide, helping to change research directions in the neurosciences.



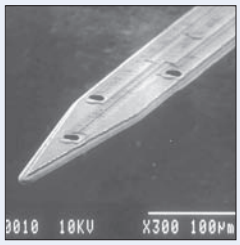
1997
First 3D CMOS probes for extracellular single-unit recording in the central nervous system.



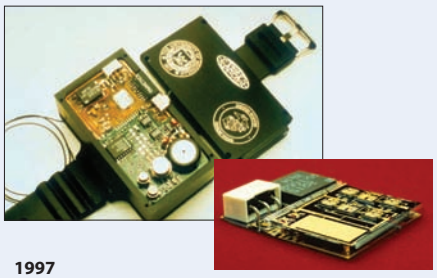
1989
This ultrasensitive silicon pressure-based flowmeter improved flow resolution by 3 orders of magnitude (reported in 1989 *IEDM* award-winning paper).



1991
The first integrated active neural stimulating array with iridium sites was realized at Michigan to advance neural prostheses.



1994
First bulk-micromachined neural probe that allowed *in-vivo* drug delivery at the cellular level along with electrical recording and stimulation.



1997
This microinstrumentation cluster flew on an unmanned aerial vehicle, up-linking data to a satellite. It was the first wireless integrated microsystem developed at Michigan, and pioneered sensor bus interfaces, sensor-circuit integration, power management, and micropower sensors for barometric pressure, temperature, humidity, shock, and vibration.

1984-1998 — Director, SRC Program in Automated Semiconductor Manufacturing (Center of Excellence). Involved several of Michigan's control faculty.

Neural Prosthesis Program – led to the development of the "Michigan Probe."

1987-1998 — Director, Center for Integrated Sensors and Circuits.

1999-2000 — Associate Dean for Research, College of Engineering

1990

2000

1998-2000 — Director, Center for Integrated MicroSystems

1989-91 Chairman, SRC University Advisory Committee

1994 Chairman, JTEC Study on Microelectromechanical Systems Developments in Japan

1995 Co-founder, Integrated Sensing Systems, Inc. (ISSYS)

ISSYS

1997 Member, Technology Working Group on Metrology, SIA National Technology Roadmap for Semiconductors

1997 General Chair, 1997 *IEEE International Conference on Solid-State Sensors and Actuators (Transducers '97)*

1998 Guest Editor, *Proceedings of the IEEE* "Special Issue on Integrated Sensors, Microactuators, and Microsystems (MEMS)"

1998-2002 Senior Editor, *IEEE Journal of Microelectromechanical Systems*

1989
IEEE IEDM Roger A. Haken Best Student Paper Award, "An Ultrasensitive Silicon Pressure-based Flowmeter," by S.T. Cho, K. Najafi, C.L. Lowman, K.D. Wise

1990
IEEE EDS Paul Rappaport Award (with K. Suzuki and K. Najafi) for paper entitled: "A 1024-Element High-Performance Silicon Tactile Imager."

1993
J. Reid and Polly Anderson Professor of Manufacturing Technology (CoE)
Stephen S. Attwood Award for Excellence in Engineering (CoE)

1995
Distinguished Faculty Achievement Award (U-M)

1996
Fellow, American Institute of Medical and Biological Engineering (AIMBE), "for contributions and leadership in the development of integrated biomedical sensors"

Columbus Prize "for an individual American who has improved, or is attempting to improve, the world through ingenuity and innovation," presented at Epcot Center in connection with the Discover Magazine Awards

1998
Semiconductor Research Corporation (SRC) Aristotle Award "for deep commitment to the educational experience of students, emphasizing student advising and teaching through research"

Elected to the National Academy of Engineering "for sensors and microelectromechanical systems"

1999
IEEE Solid-State Circuits Field Award "for pioneering contributions to the development of solid-state sensors, circuits, and integrated sensing systems"

1990 Jin Ji
Euisik Yoon
Christy Lynn Johnson

1991 Steve T. Cho
Mahmoud Ghazzi

1992 Arnold C. Hoogerwerf
Steven J. Tanghe
Nader Najafi

1993 Lai-Cheng Kong

1994 Yafan Zhang
Changhyun Kim

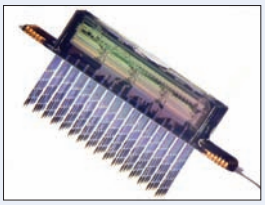
1996 Paul L. Bergstrom
Jingkuang Chen
Janet K. Robertson
Jennifer L. Lund

1997 Andrew D. Oliver
Richard J. De Souza

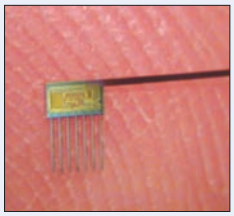
1998 Tracy Elizabeth Bell
Jinsoo Kim

1999 Qing Bai
Uksong Kang

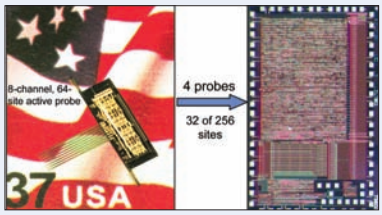
2000 Abhijeet V. Chavan
Collin A. Rich
Andrew J. Mason



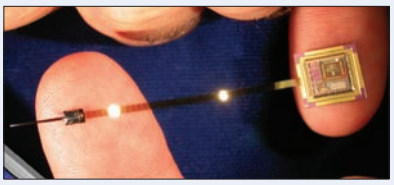
2000
First high-density 3D neural probe array for exploring the organization of the central nervous system.



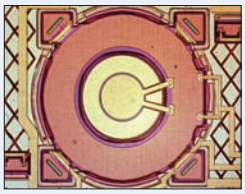
2002
First neural probes containing on-chip CMOS circuitry to record activity in unrestrained animals (collaboration with Rutgers University).



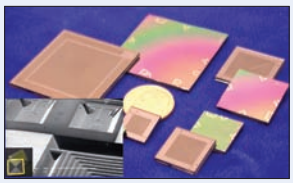
2004
First programmable neural digital signal processor, developed as part of a 256-site system.



2005
This thin-film silicon-parylene array, the first of its kind, was a major step toward improving the frequency range and resolution in cochlear prostheses (reported in 2005 *IEDM* award-winning paper).

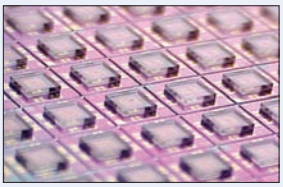


2000
A vacuum-sealed pressure sensor used to allow closed-loop control of an 8b integrated flow controller.

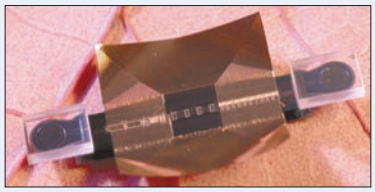


2004
Deep silicon etching technology is used to realize the highest performance chromatographic separation microcolumns in the world.

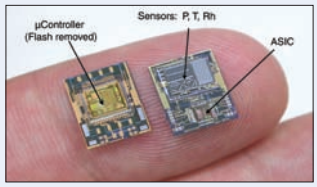
2006
Parylene-insulated gold lead structures are realized to enable folding microsystems for the first time.



2001
These barometric pressure sensors were the first to integrate a closed-loop vacuum control system into their reference cavity, achieving 25mTorr accuracy.



2004
First reported pressure/flow-sensing microsystem for use in an arterial stent.



2005
This 0.15cc microsystem for sensing pressure, temperature, and humidity is a signature example of a generic integrated microsystem.

2000-2010 Director, NSF ERC in Wireless Integrated MicroSystems (WIMS)

2000

2000 Member, National Research Council (NRC) Study Group on Biotechnology for Army Applications

2000 *Fantastic Voyage:* Microsystem Development at the University of Michigan 1975-2000

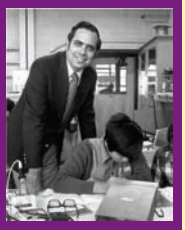
2005

2003-05 Member, NRC Study Group on Engineering the Health Care System

2006

Courses Developed

1974 Monolithic Device Structures, *major revision*
1975 Analog Integrated Circuits, *new course*
1975 Solid-State Device Laboratory, *major revision*
1976 Integrated Circuits Laboratory, *major revision*
1976 Digital Circuits Laboratory, *new course*
1987 Digital Integrated Circuits, *new course*
1994 Integrated Sensing Systems, *new course*
2002 Societal Impact of Microsystems, *new course*



Prof. Wise regularly taught the Integrated Circuits Laboratory. In 1976, the class project was a 64-bit SRAM chip. Thirty years later, the technology was more complex and the facilities were much better but the goal was the same - to introduce students to the creation of a complete chip.

10 Years of WIMS

Doctoral students graduated:	>150	Participating Universities:	10
Pre-College short courses:	88	Departments/Disciplines:	16
Pre-College short course students:	4,000	International Alliances:	>10
Journal articles published:	306	Patents awarded:	59
Archival conference papers:	>700	Spinoff companies:	12
Core Faculty:	49	Economic impact:	$400M

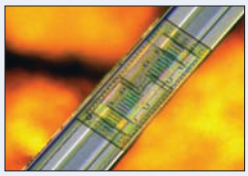
2002
William Gould Dow Distinguished University Professor (U-M)

2005
Michigan Emerging Industry Pioneer Award "In recognition of outstanding leadership to the MEMS, MicroSystems, and Nano Technology Community"

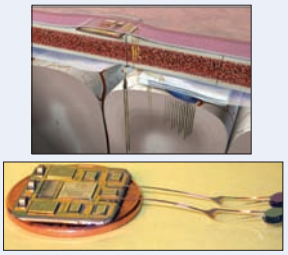
2005
IEEE IEDM Roger A. Haken Best Student Paper Award, "An Integrated Position-Sensing System for a MEMS-Based Cochlear Implant," by J. Wang, M. Gulari, and K. D. Wise

Students

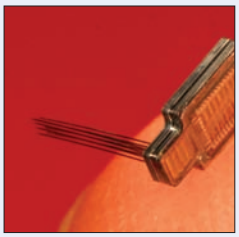
2001 Demetrios Papageorgiou
2002 Marcus D. Gingerich
Patty Chang-Chien
2003 Brian G. Jamieson
2004 Andrew David DeHennis
Roy H. Olsson III
2005 David Frederick Lemmerhirt
Masoud Agah
Ying Yao



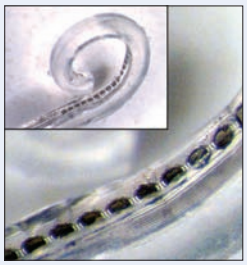
2006
Thermal flowmeters are successfully integrated on the 40μm-wide shank of a neural probe for the first time to meter drug delivery at the cellular level.



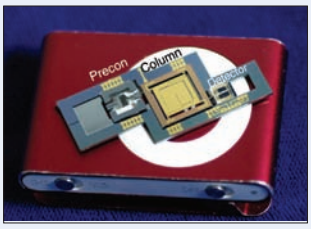
2007
This wireless implantable electrode array was developed for capturing control signals from the motor cortex, fitting on a U.S. penny. It was the first such array ever realized.



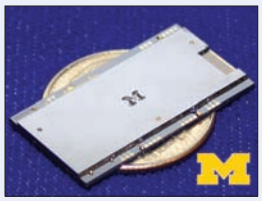
2008
First neural recording array to use deep reactive ion etching to realize high-yield 3D electrode arrays. These electronic interfaces to the nervous system are leading to prostheses for deafness, blindness, epilepsy, paralysis, and Parkinson's Disease.



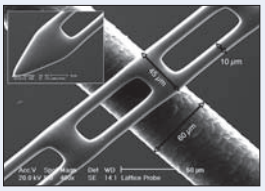
2010
First cochlear implant array specially designed to achieve the stiffness and curl needed for deep insertion, setting the stage for an automated insertion process that will take cochlear implants to the limits set by physiology.



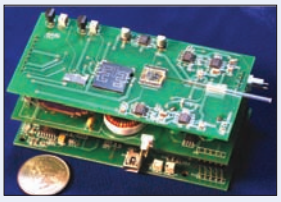
2010
Orion is a prototype gas analyzer that explores the fundamental limits of chromatography-based gas analysis systems in terms of power, speed, and size. Such devices could revolutionize security, environmental monitoring, food processing, and health care by enabling low-cost, widely-deployable gas analysis. Allows breath analysis to determine tuberculosis and lung cancer.



2006
A chromatographic separation system is realized in a structure a little larger than a dime, advancing miniature gas analysis systems.

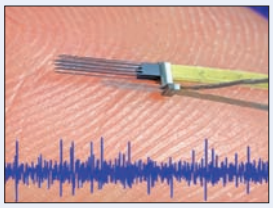


2007
Lattice probe structures, shown on a human hair, are developed to reduce the tissue reaction to electrode arrays implanted in the body.



2010
First palm-size completely integrated gas chromatograph system ever implemented. Called Mercury, it included temperature control electronics, an embedded processor, and a USB interface.

2010
These pressure sensors, shown on a U.S. penny, were developed for a 1mm^3 intraocular microsystem for treating glaucoma. The microsystem also includes an ultra-low-power processor, energy-scavenging power system, and a wireless interface.



2010
This high-density neural probe array pioneered mapping of the auditory system, exploring the mechanisms responsible for tinnitus.

32 Patents

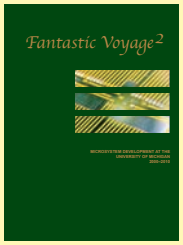
2007 — 2010 — 2011

2007-2011 Director, Solid-State Electronics Laboratory

2007 Chair, Evening Special Topics Session on Implantable and Prosthetic Devices: Life-Changing Circuits" at ISSCC

2008 Co-Chair, NSF Workshop on Micro/Nanoelectronics: Devices and Technologies for Biomedical Applications

2008
Dedication of the Lurie Nanofabrication Facility



2010
Fantastic Voyage 2: Microsystem Development at the University of Michigan 2000-2010

2011-present Ken Wise Retires – yet continues to work on research projects.

Research Highlights:

- Realized the first thin-film cochlear electrode arrays for the hearing impaired.
- Realized wireless implantable microsystems for monitoring neural activity in motor cortex
- Demonstrated wireless pressure sensors to improve cardiovascular care, the treatment of glaucoma, and environmental monitoring.
- Developed smart air-quality monitors to help address global warming.
- Demonstrated hand-held breath analyzers for biomarkers of tuberculosis and lung cancer for use around the world.

2006
Purdue University Outstanding Electrical and Computer Engineer

2007
Henry Russel Lectureship (one of the highest honors bestowed by U-M)

2010
Technology Transfer Career Achievement Award (U-M)

2011
Distinguished University Innovator Award (with Khalil Najafi), for their role developing breakthrough technologies in microelectromechanical systems (MEMS) and working with colleagues, students and industry partners to move these innovations from university laboratories to new startups.

2006 Pamela Tridandapani Bhatti
Joseph Allen Potkay
Helena K. L. Chan
Yang Li

2007 Jianbai Wang

2008 Gayatri Eadara Perlin
Kyusuk Baek

2009 Mikhail Pinelis

2010 Sister Mary Elizabeth Merriam

2011 Razi-Ul Haque
Angelique Johnson

(Continued from page 43)

Shortly after, the path to the NSF Center for Wireless Integrated MicroSystems (WIMS) was set when Ken and Khalil decided to begin the long process of proposal submission in 1998. Ken took on the role of Associate Dean for Research at the College of Engineering in 1999, but when NSF funded the Center, he stepped down after just a year to direct WIMS. Twenty-five years of research and dedication provided the perfect launching pad for this ten-year Center.

00's: Wireless Integrated MicroSystems and the LNF

"We had been mainly a MEMS device group," said Ken. "The big thing about WIMS was it crystallized efforts in wireless as well. That's a paradigm shift. The combination of sensing with embedded low-power circuits and wireless is going to be everywhere."

When Ken took over as Director of WIMS, he truly began to write his own history – through the newsletter *WIMS World*. His Director's Messages reveal his love for history interwoven with reflections on leadership, team building, dedication, students, education, and of course the research: testbeds, system integration, microsystems, and the power of engineering to change society for the better.

WIMS World charts his progress in realizing his dream for *in vivo* implantable devices with wireless monitoring; cheap, efficient, devices for environmental monitoring; and a neural prosthesis for the treatment of deafness, epilepsy, Parkinson's disease, and perhaps even paralysis.

As the WIMS Center got under way, it was clear that for Michigan to continue its state-of-the-art research in MEMS as well as other areas in Solid State, attention must again be turned to equipment and facilities. Again, the Deans (the process began under Dean Steven Director, was expanded under Interim Dean Ronald Gibala, and completed by Dean David C. Munson, Jr.) stepped up and helped make it happen, with the help of alumni and friends of Michigan Engineering.

A key friend was Ann Lurie, long-time supporter of Prof. Wise's research with its direct application to healthcare. She launched the fundraising effort with a $15M gift, and many others stepped up to ensure completion of the $40M expansion and renovation. Another $20M in equipment from the University completed the facility. The College had the names of a few select donors printed on a plaque commemorating their gifts; included are Ken and JoAnne Wise.

At the dedication of the Robert H. Lurie Nanofabrication Facility in 2008, Ken told the crowd that he was as excited as anyone to see what future breakthroughs would be accomplished at Michigan thanks to the facility and the synergy of the faculty and students.

The WIMS Center is the crowning jewel in the remarkable career of Ken Wise. In the booklet, *Celebration: The WIMS ERC: 2000-2010*, he remarked that the microsystems now being developed "are creating a new electronics that will become truly pervasive in solving many of the critical problems of this new century. It will help us preserve the environment, improve health care, protect our national and global infrastructure, provide homeland security, and improve the discovery, generation, distribution, and use of energy."

The ribbon cutting ceremony for the Lurie Nanofabrication Facility

He saluted the people that made it all possible – with particular gratitude for his faculty colleagues who were willing to put aside their own personal research agendas to work for a common goal and make these microsystems a reality.

The Team, the Team, the Team

Ken arrived at Michigan with a vision for building a program in a new field based on sensor technology that would come to be known as MEMS and microsystems. Even in the early days, sensor research was highly interdisciplinary, and Ken gradually drew many others into his world.

He worked with a group of faculty dubbed the "fab five" in the 90's, and when three left for other opportunities, he seamlessly worked in their successors to be research thrust leaders in the WIMS Center. Khalil Najafi remained a member of the team, and the new members from EECS were Yogesh Gianchandani, Dennis Sylvester, and Michael Flynn. It was this "fab five" team, along with Ted Zellers from the School of Public Health, that was awarded the CoE Ted Kennedy Team Excellence Award in 2010 for their work in MEMS and microsystems.

L: Khalil Najafi, Ted Zellers, Yogesh Gianchandani, Michael Flynn, Dennis Sylvester, Ken Wise

A critical component of Ken's team were his students. He created an environment where they felt comfortable yet challenged – a tricky balance to achieve. Even in the early years he attracted a relatively high proportion of under-represented minorities, which in engineering includes women. These students have gone on to excel in industry, academia, and, like his final student Angelique Johnson, new startup ventures.

Memories and Remembrances

The research accomplished at Michigan under Ken's leadership was extraordinary. But it is not at the heart of his work. For that – you'd have to look at the people in his life.

His family was his rock – his pride and joy. Of his wife JoAnne, he said "it's really all about her, because she made it all possible for me." He treasures the time spent with his three boys, Kevin, David, and Mark, and over the years he has fulfilled a number of significant positions in his church.

In the research realm, Ken said, "A lot of my favorite memories involved working with Khalil, especially in the early days when we were trying to build the program. Trying to get a proposal out at the last minute – sacrificing a lot but making it work, even when we really didn't have enough money or time."

"My fondest memories, said Ken, are working with my students, and pulling it off." As Ken was answering this question, a former student came by to say hello – she was using the cleanroom on behalf of her solar energy firm. Many more students came to a special banquet held in September 2010 to celebrate his career at Michigan.

At the banquet, first PhD student, John "Mike" Borky (PhD EE '77), said that Ken established a unique personal relationship with every one of his students, and added, "The knowledge, the discipline, the passion for excellence that Ken and the whole University community imparted were the foundation for all that I did after and all the success that I enjoy."

A more recent student, Andrew DeHennis (MSE PhD EE '01 '04), said he was able to fully appreciate Prof. Wise's vision when, "within a couple years of graduating and being in industry, I developed another remotely powered wireless monitoring system that we are implanting in humans." He began research in this area with Prof. Wise in 1999.

His last student, Angelique Johnson (PhD EE '11), recalled Ken coming in at 7am Saturday mornings to teach Detroit area middle schoolers about MEMS technology. She said she truly appreciated "how much Dr. Wise encouraged his students to reach back into the community, and to influence young minds to get into this field. He pushes his students to excel as human beings, not just researchers. He wants us to achieve more than just new technology. He wants to help us achieve a better world overall."

Looking to the Future

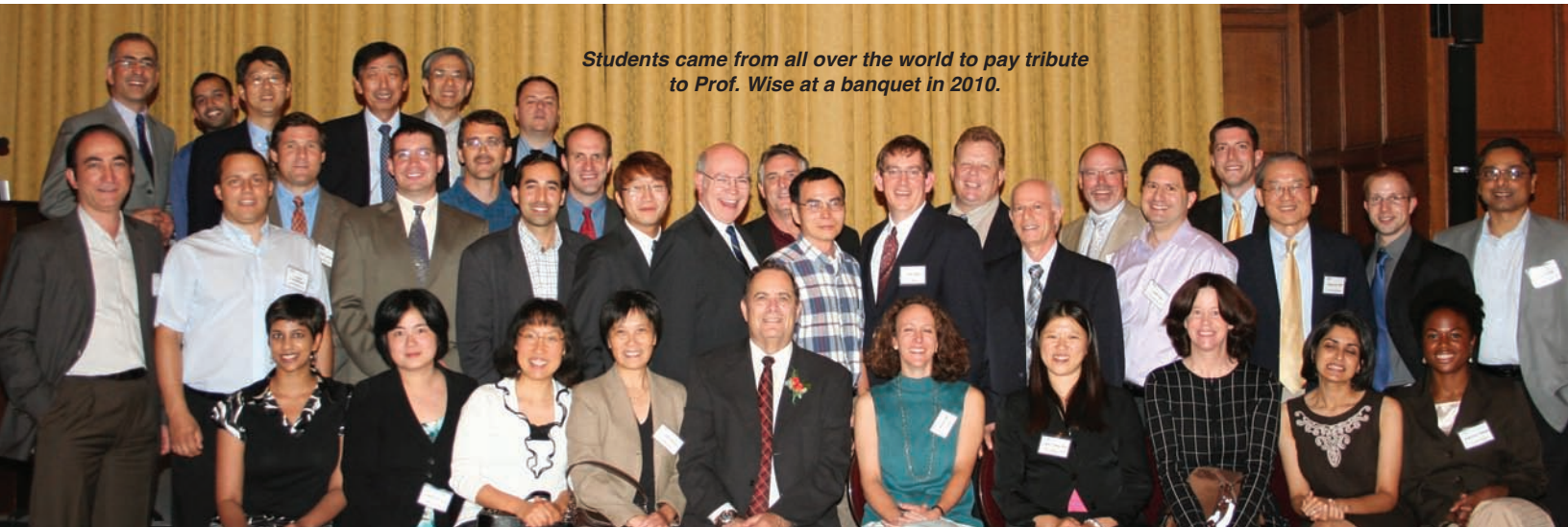
Ken's vision has always been focused on a future built on a firm foundation. During his tenure as WIMS Director, he provided an abundance of writings, photos, and presentations documenting the history of the Center, and then worked diligently to ensure its continuation once NSF funding had ceased. WIMS^2 is now directed by his academic "grandson" Yogesh Gianchandani, student of Khalil Najafi.

Ken's career here at Michigan is well summarized by his former student, long-time colleague, and friend Khalil Najafi:

"Ken has been the visionary, the guiding light, and the steady hand who has devoted his career to the creation and development of an amazing set of technologies and devices that have benefited everyone across the world. He is a humble and devoted researcher and teacher who shared his success, his resources, his counsel, and his vision with all of us. He focused the spotlight mostly on us, shying away from drawing attention to his own accomplishments and needs."

"By combining micropower circuits, wireless interfaces, and integrated sensors, a flood of advances has been unleashed to improve health care, the environment, the national infrastructure, and other areas, changing the way we live and improving the quality of life. Ken helped launched this revolution, and it will have far more impact than any of us can imagine." ●

"Michigan was a great place to spend a career."
– Ken Wise



Students came from all over the world to pay tribute to Prof. Wise at a banquet in 2010.

MSuite Collaborative Kicks Out the Apps!

The MSuite Student Collaborative, a cross-disciplinary student group, has taken up the production of mobile apps in a big way at Michigan. Advised by Dr. Jeff Ringenberg, MSuite has become the "go to" group for the production of mobile applications to be deployed throughout the University. MSuite was formed a year ago when a team of eight students working with Dr. Ringenberg developed a Mobile CTools app that was bought by the University; since then, the group has grown and has developed mobile clients for the Mobile Participation System classroom response system, a guide to the U-M hospitals, a course guide app, an app for the School of Nursing, an app for the Mott Hospital Tile Project, the Android tablet controller for the Michigan Autonomous Aerial Vehicles team, and has two apps under continuous development for the athletics department.

Students Demo Mobile Apps at iOS Showcase

Student app programmers had another opportunity to show off their wares at the second annual iOS Showcase in March 2012. Sponsored by Apple, the event showcased 11 teams of iOS developers and their functioning apps. This year, apps included an interactive multimedia rendering of a famous children's book, a simple and easy method of encrypted text message communication, an end-to-end solution for K-12 student project development and oversight, as well as apps for sharing photos in real time, for locating parties and events, for transfering files, and more.

ECE Poster Session at the Engineering Graduate Symposium

More than 90 research posters were presented by graduate students in Electrical and Computer Engineering at the 2011 College of Engineering Graduate Symposium, November 11, 2011. Their research included techniques for studying brain function and treating neurological disorders; techniques for cancer detection; different approaches for improved solar cells; novel techniques for energy scavenging; cutting-edge research in terahertz technologies for various applications; faster and safer MRI scans; integration of optoelectronic and electronic components for continued performance gains in integrated circuits; miniature antennas for wireless devices; nanospacecraft thrusters; energy-hub power networks; the power grid; advanced methods to control walking and running in robots; energy optimization in electronic devices; and techniques for object detection for vision and robotic applications.

Students also presented their research during technical sessions. The following students earned first place in their respective sessions:

Vikrant Gokhale (MEMS & Mechatronics)
Vasudev Lal (Photonics & Applied Physics)
Mads Almassalkhi (Power & Control)
Young Jun Song (RF & Applied Electromagnetics)
Matt Prelee (Signal Processing & Computer Vision)
Anne Itsuno (Solid-State Materials, Devices, and Physics)
Yang Liu (Systems Engineering, Control & Communication)

Michigan Hackers – New Student Group Supports Experimenting With Technology

A new student group has formed to support the creative urges of students with a passion for technology. Whether a student is prototyping a new hardware product or writing an innovative web or mobile app, Michigan Hackers aims to be the first on-campus resource he or she turns to for advice and community.

The group spent the Winter '12 semester building its brand on campus and gaining recognition. They hosted two tech talks, both of which drew 30+ attendees, and helped over 50 U-M students gain free education accounts on Github, a popular cloud solution for the DVCS tool Git. This fall, the group seeks to host tech talks, hackathons, group work sessions, mock technical interviews, and social gatherings with the goal of empowering a network of talented "hackers" with great opportunities, both on and off campus.

According to President Max Seiden, "Although just a few similar groups have emerged at peer institutions, this type of highly organized, "hacker" student group is relatively new on campuses. As we move forward, we will definitely think of ways to connect with other organizations across the country."

Interdisciplinary Teams

UM::Autonomy

Serenity, UM::Autonomy's robotic boat, took first place for the second time in its four years of competition at the RoboBoat competition, formerly known as the International Autonomous Surface Vehicle Competition, held June 20–24, 2012.

The interdisciplinary team went into the competition this year with a new electrical and vision system, and an advanced control system. So while the competition takes place in water, it takes a heavy dose of EECS know-how to pull off a win.

Member of the team
Back row L-R: Eric Rossetti (EE), Anthony Bonkoski (CE, Electrical Team Leader), Steve Ratkowiak (ME), Tyler Olsen (ME), Raghav Ramkumar (ME with EE minor), Jakob Hoellerbauer (EE)

Front row L-R: Nikki Kudzia (NAME), Michelle Howard (EE)

The addition this year of a fiber optic gyro helped Serenity navigate the bouys with ease.

The "brains" of Serenity included a specially designed simultaneous localization and mapping system, as well as a new fiber optic gyro.

A Lighter and Faster Solar Car, Quantum, Races to a Record-breaking Win

The University of Michigan's student-run Solar Car team continues to dominate in national and international competition. Their latest car, Quantum, finished 3rd at the 2011 World Solar Challenge, where they were up against teams that tap into professional talent. This is the fifth time the team has reached this level – and they are still hungry for the big win in international competition.

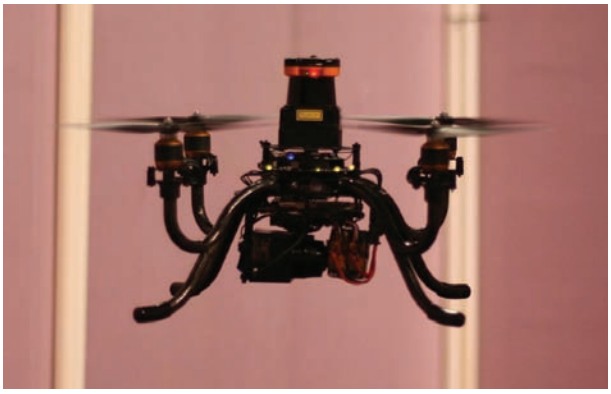
With no time to rest – the team raced Quantum in the 2012 American Solar Challenge, earning them their fourth consecutive American title, and breaking the current national record in the process. "It is exciting and a relief," said crew chief and recent electrical engineering grad Ryan Mazur. "We have proven that Quantum is a great car and made all our alumni proud." This year's car shed 200 pounds from the last car, Infinium, and was 30 percent more aerodynamic.

Ryan Mazur (BSE EE 2012), the team's crew chief, behind the wheel.

The Solar Car Team after winning the 2012 American Solar Challenge.

Interdisciplinary Teams

Michigan Autonomous Aerial Vehicles

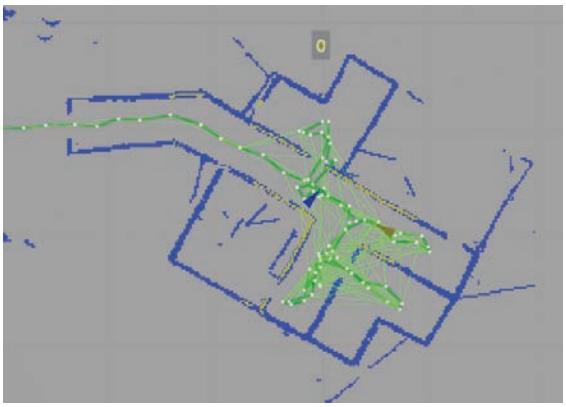


The MAAV quadrotor flies into the competition area.

The Michigan Autonomous Aerial Vehicles (MAAV) team took first place at the 2012 International Aerial Robotics Competition (IARC). The MAAV team, founded in 2009, successfully maneuvered and mapped the set course with their unmanned aerial quadrotor vehicle. The contest required vehicles to navigate autonomously through the window of a building, retrieve a flash drive from a table, replace it with a decoy, and exit the building – all while avoiding laser tripwires and security cameras.

Key to the team's win was sensing and artificial intelligence technology that EECS team members integrated into the vehicle. The vehicle uses LIDAR data it collects to build and store a detailed map of its environment so that it is continuously learning about its surroundings and reacting accordingly. Once its "map of the world" has been created, the quadrotor not only travels from point to point quickly and with less operator oversight, it also hovers accurately in a very precise location.

Of the thirteen students in the team, seven are from EECS and six are from Aerospace Engineering. EECS students were essential to designing the system's electronics, control, sensing, mapping, and decision-making systems.



The path taken by the quad rotor during the competition (green) and its mapped boundaries (blue).

The 2012 MAAV team (L-R): Brian Fulper, Isaac Olson, Yiying Li, Ryan Moore, Joe Potter, Danny Ellis, Jose Gomez, Sam DeBruin, Jon Kurzer, Tom Brady. Not pictured: Pratik Agarwal, Jonathan Bendes, David Hash.

Michigan Hybrid Racing

There's a new team in town, and it's called Michigan Hybrid Racing.

In its first year competing in the Formula Hybrid International Competition, the team finished 10th in the design category. They were one of forty teams from five countries competing at what has been called the world's premier competition for student built hybrid race cars. The goal is to make maximum use of both available fuel and battery power. Car makers attend the event to recruit students, seeing the event as ideal training for work in their companies.

EECS students primarily worked on the power electronics (including building a battery charger) and on the control system of the car to optimize the vehicle for either power or fuel efficiency depending on the racing event. They are currently working on the design of their second car and hope to field two cars, one all electric and the other a hybrid, in future years.

Student Competitions

Students Compete to Create Game-Playing Bots in Weekend Competition

Sixty U-M student programmers spent 24 hours on September 30 and October 1, 2011 designing and optimizing intelligent game-playing "bots" as part of an innovative contest sponsored by Barracuda Networks and CSE. The bots were designed to compete and win the Milton-Bradley card game Rack-O. The students, in teams of one to four, spent about 20 hours designing and improving their bots. The event culminated in a three-hour final tournament between the bots to determine the winning programmers. Winners were:

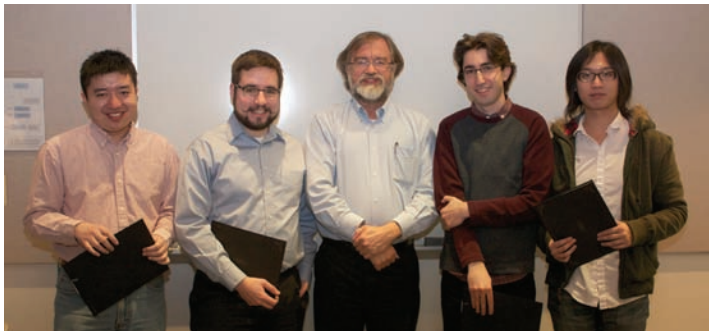
1st Place: **Mark Gordon;** *2nd Place:* **Yi-Chin Wu, Chih-Chun Chia**, and **Shang-Pin Sheng;** *3rd Place:* **Guoxing Li, Zhongshu Jin**, and **Lin Hao Peng**

EECS 494: Computer Game Design and Implementation
Prof. John Laird
Sponsors: Microsoft and Electronic Arts

1st Place: "Battle Bender," by **Mark Dehring**, **Isaiah Hines, Corbin Phelps**, and **William Price**

2nd Place: "Ghost Planet," by **Cody Bird**, **Ryan Meier**, and **Joe Mitchell**

3rd Place: "Bananarchy," by **Stephen Fulcher, Travis O'Sullivan**, and **Steve Wishnousky**



Yi Li, Joseph Greathouse, Prof. Benjamin Kuipers, Vahed Qazvinian, and Li (Eric) Qian.

CSE Graduate Student Honors Competition Highlights Exceptional Research

CSE concluded its eighth annual Graduate Student Honors Competition on December 8, 2011, when four finalists each gave a summary presentation on an area of their research. Finalists were:

1st Place: **Joseph Greathouse**, ACAL, "Hardware Support for On-Demand Software Analysis"

2nd Place: **Vahed Qazvinian**, AI, "Using Collective Discourse to Generate Surveys of Scientific Paradigms"

Honorable Mention: **Yi Li**, Theory, "Approximate Sparse Recovery: Optimizing Time and Measurements;" and **Li (Eric) Qian**, Software, "User-Friendly Information Integration."

Cydonia explores the Utah desert.

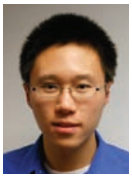
Mars Rover Team

The Michigan Mars Rover Team is a student research group with a mission to develop manned ground vehicles for planetary exploration. The team fielded their new vehicle, Cydonia, to finish in fourth place in the 2012 University Rover Challenge (URC) at the Mars Desert Research Station. This was the third year that the team entered the competition and their best showing to date.

EECS students worked on the rover's motor controls and driving system, all of the electrical systems, the system programming, and the robotic arm that is key to the rover.

Individual Honors and Awards

Christopher Berry (BSE MSE EE '07 '10 and current EE graduate student) received a fellowship from the Michigan Space Grant Consortium for research in the area of terahertz technology for Space



David Chen (EE graduate student) received a fellowship from the Natural Sciences and Engineering Research Council of Canada for his research on RFI detection and mitigation for Space applications

Jihyun Cho (EE graduate student) received a Rackham International Fellowship for his research in the area of CMOS image sensors.

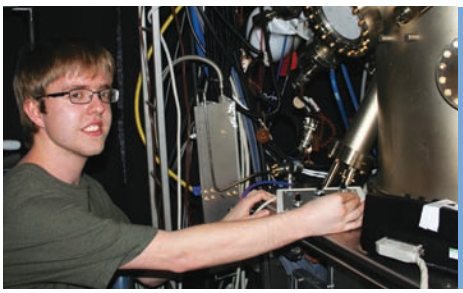
Jason Clemons (MSE CSE '02 and current CSE graduate student) received an NVIDIA Graduate Fellowship for his work in his work in developing applications and computer architectures for a mobile vision system.

Jason also won the GSRC Margarida Jacome Best Poster/Demo Award at the Annual Symposium of the Gigascale Systems Research Center for "Visual Sonification Project."

Heather Ferguson (EE graduate student) received an NSF Graduate Research Fellowship to pursue her research in optical sciences.

Fikadu Dagefu (EE graduate student) received a Lincoln Lab Fellowship to pursue his research in applied electromagnetics, which includes devising efficient models for near-ground wave propagation and scattering in complex indoor and urban scenarios.

Laura Freyman (EE graduate student) received an NSF Graduate Research Fellowship to pursue her research in integrated circuits.



Thomas Frost (BSE EE '11 and current EE graduate student) received an NSF Graduate Research Fellowship for his research in the area of semiconductor lasers.

Samuel DeBruin (CSE graduate student) received a National Science Foundation Graduate Research Fellowship to pursue his graduate studies in computer science and engineering.

Nate Derbinsky (MSE PhD CSE '08 '12) won the Best Poster Award at the *11th International Conference on Cognitive Modeling (ICCM)* for "Computationally Efficient Forgetting via Base-Level Activation."

Hector Garcia (CSE graduate student) received a Rackham Centennial Spring/Summer Fellowship for his work in designing efficient tools that identify and analyze potential advantages and pitfalls in emergent quantum information processing technologies.

Michael Hand (BSE EE 2011 and current EE:Systems graduate student) received a Tau Beta Pi Fellowship.

Dongyoon Lee (MSE CSE '09 and current CSE graduate student) received a VMWare Graduate Fellowship for his work in improving the programmability of parallel computer systems.

Individual Honors and Awards cont.

Avishay Livne (CSE graduate student) received a Rackham International Student Fellowship for his work in studying dynamics in social networks by using network analysis and text mining techniques.

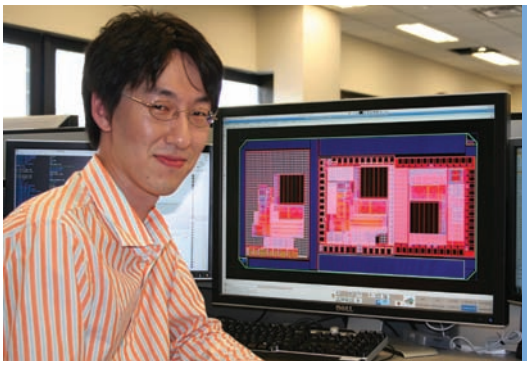
Maya Spivak (CSE graduate student) received a National Science Foundation Graduate Research Fellowship for her work in low-level software for embedded systems and computer architecture.

Biruk Mammo (CSE graduate student) received a Rackham International Student Fellowship for his work in developing solutions to more efficiently assist processor designers in identifying and diagnosing functional errors in their designs.

Max Seiden (CSE graduate student) was selected as a KPCB Engineering Fellow by venture firm Kleiner Perkins Caufield Byers and will work with their portfolio company One Kings Lane.

Russell Willmot (EE graduate student) received an IEEE Life Member Graduate Study Fellowship to pursue his research in the area of RF Circuits and Applied Electromagnetics.

Shang Hua Yang (EE graduate student) received a SPIE Scholarship in Optics & Photonics to advance his research in the area of high-performance terahertz sources.



Yoonmyung Lee (EE graduate student) received an Intel Corporation PhD Fellowship to pursue his research in circuit design challenges for new technologies.

Chunyang Zhai (EE graduate student) received a Rackham International Student Fellowship to support her research in the area of analog and mixed-signal circuits, which she is applying to infrastructure health monitoring.

Sung Ho Park (EE undergraduate student) received an IEEE Microwave Theory and Techniques Society Undergradute/ Pre-Graduate Scholarship.

Randy Schiffer (BSE EE '11 and current EE graduate student) received an Innovations in Fuel Cycle Research Award from the U.S. Department of Energy, Office of Nuclear Energy, Fuel Cycle Research and Development.

Vahed Qazvinian (PhD CSE '12) received a Rackham Centennial Spring/Summer Fellowship for his work in exploiting online collective content contributions to build better summarization and decision support systems.

Srinath Sridhar (EE:Systems graduate student) received a Rackham International Student Fellowship for his research in the area of computer vision.

EECS and CoE Awards for Academic Year 2011/12

Undergraduate

CoE Henry Ford II Prize
Calvin McCarter (CS)

CoE Arlen R. Hellwarth Award
Eric Rossetti (CE)

CoE Distinguished Academic Achievement Award
Rebecca Frank (CE)
Paul Rigge (EE)
Patrick Theisen (CS)

CoE Distinguished Leadership Award
Michael Hand (EE)
Aryn Lipnicki (CSE)

CoE Cooley Writing Prize
Nick Ruff (CS), fiction category

EECS Outstanding Achievement Award
Rebecca Frank (CE)
Rebecca Moore (CS)
Paul Rigge (EE)

William L. Everitt Student Award of Excellence (EECS)
David Bernthal (CS)
Anthony Bonkoski (CE)
Haoran Li (EE)

EECS Outstanding Research Award
Rebecca Frank (CE)
Brett Kuprel (EE)
Alex Robinson (CS)

EECS Outstanding Service Award
Sam DeBruin (CE)
Aryn Lipnicki (CS)
Caroline Thompson (EE)

EECS Commercialization/ Entrepreneurship Award
Mitch Adler (CE)
Connor Field (EE)
Kedao Wang (CS)

William Harvey Seeley Prize (EECS)
David Hiskens (EE)

EECS Instructor's Aide Award
Tom Frost (EE)
Patrick Pannuto (CE)

Honorable Mention
Varun Annadi (EE)
Jonathan Plotzke (CS)
Irene Zhu (EE)

Graduate

Richard F. and Eleanor A. Towner Prize for Distinguished Academic Achievement
Hyoun Kyu Cho (CSE)
Ali Kakhbod (EE:Systems)
Sudhir Satpathy (EE)

Tom S. Rice Tau Beta Pi Award
Michael Hand (EE:S)

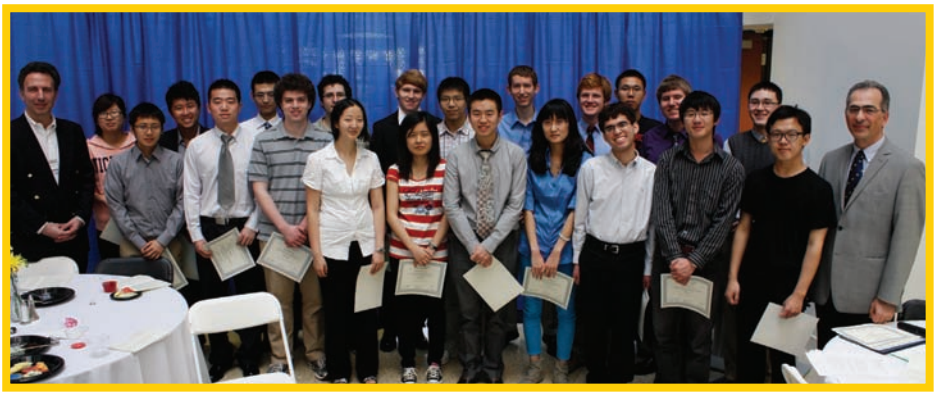
MLK Spirit Award
Iverson Bell (EE)

Richard F. and Eleanor A. Towner Prize for Outstanding GSI's
Andrew DeOrio

EECS Graduate Student Instructor (GSI) Award
Travis Martin (CSE)
Sudarshan Sivaramakrishnan (EE)
Praveen Yenduri (EE:S)

Honorable Mention
Robert Perricone (CSE)
Seyit Sis (EE)
Yefei Wang (EE:S)

Yahoo! GSI Award for CSE Students
Andrew DeOrio
Joshua Lim



Alumni Spotlight

Tom Conrad

Motivated by the Music

Tom Conrad
Chief Technology Officer
Pandora
BSE CE '92

PANDORA®

He was the guy with the giant collection of music CDs who always wanted to play his latest find for you. Tom Conrad arrived at Michigan in 1988 with two passions: music and computers. He had no idea then that those two, separate sides of his life would ultimately dovetail into the ultimate career.

As a high school student, Tom set his sights on Michigan, with the goal of moving to California and working for Apple after graduation. "I was 15 years old when the Macintosh came out, and was absolutely fascinated with the dawn of the GUI and the new era of user-friendly computing. It was clear to me that the people at Apple were out to change the world, and that I had to join them. I decided to become a computer engineer, and after visiting Michigan and being on campus, I knew that not only did Michigan have a great CE program, it just felt like the right place for me to pursue my dream."

While a U-M student from 1988 – 1992, Tom worked in the CAEN visualization lab, which was chock-full of refrigerator-sized graphics computers that were dedicated to creating 3-D images and other visualizations. Most of the money he earned at CAEN went straight to amassing his collection of about 1000 CDs.

"Most of the money he earned as a student working at CAEN went toward his collection of over 1000 CDs."

At CAEN, Tom joined a cadre of a dozen or so students who worked in the lab or were responsible for maintaining the numerous Apollo and Macintosh systems spread throughout CAEN. Many in this group shared his dream and made the pilgrimage to intern at Apple, and in 1991 Tom traveled to Cupertino for his own internship, sleeping on an inflatable mattress at the foot of U-M alum and recent Apple employee Steve Faulkenberg's bed. "That internship was a great experience for me, and it paved the way to a permanent job at Apple."

After graduation, Tom joined Apple and spent three years working on the Finder team, which designed the primary user interface for the Mac.

Although Tom loved Apple, in 1995 Netscape had launched and Yahoo! had gone public, and the Internet had become an irresistible technical and commercial opportunity. Tom left Apple to join Berkeley Systems and also became the technical director for the "You Don't Know Jack" video game series. He found that the smaller Berkeley Systems environment, where he managed a team of programmers, was the place where he truly developed his chops as a commercial software developer.

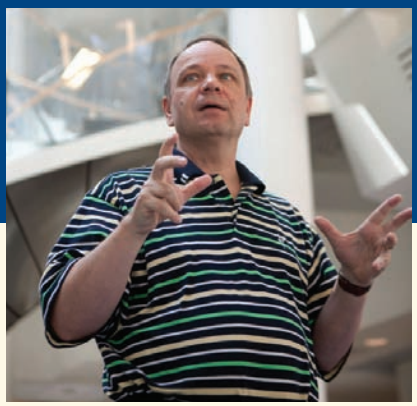
In the years that followed, Tom rode the peaks and valleys of the tech boom, always following his passions. This included getting in on the ground floor at Relevance Technologies in 1998, which built back-end search and personalization for documents on the Internet. After a year, the company sold for $40M. Inspired by his adoption of a dog, Tom joined Pets.com and led engineering from the company's founding through its high-flying success until it crashed and burned when the Internet bubble burst.

In 2004, Tom decided to find a way to combine a love of music with the personalization technologies he'd mastered at Relevance and the consumer web development skills he'd developed at Pets.com. By chance, he learned through a connection that just such a venture had recently been formed. He joined that firm – now known as Pandora – as CTO, and hasn't looked back.

Today, Tom oversees hundreds of people at Pandora with responsibility for product management and design, software engineering, technical operations, Pandora's Music Genome Project®, customer service, and internal IT.

Reflecting on his experience, Tom says that "the opportunity to go to a school where Apple and similar companies recruit every year, where your peers are motivated to make a difference, and where you can dream big and take advantage of great connections – that has to be the most valuable thing I gained from Michigan. I'm certain that if I had gone to another school I would have gotten a fine engineering education, but my whole life would have been different because I wouldn't have had the advantages I had at Michigan." ●

Alumni Spotlight



Sid Meier

The Godfather of Games

Sid Meier
Co-Founder and Director of Creative Development, Firaxis Games
BS 1975, LSA Cpt&Com Sc.

FIRAXIS GAMES

"Michigan was where I was introduced to computers," says Sid Meier. "It's hard to visualize the world of the 1970s now, when we didn't walk around with computers in our pockets and access to the Internet 24/7. It was a very different world, so when I came to the University I had no idea that I was going to be interested in computers."

Sid Meier arrived at the University in 1971 with an interest in chemistry, physics, and math. Needing a job, he applied for a workstudy position with physics professor Noah Sherman, who happened to be interested in computer-assisted learning. Since Sid was already taking one programming course, Prof. Sherman hired him with the expectation that he would pick up what was needed in this new area as they progressed. The assignment jump-started Sid's interest in the potential of computers and computing, and he ultimately selected a CS concentration.

Civilization V is the most recent of the genre-shaping Civilization game series.

One summer, Prof. Sherman was traveling and had given Sid some assignments to complete. This included an artificial intelligence project that Sid addressed by teaching the computer to play tic-tac-toe. In those days, programs were run on punchcards, and printouts of results were sorted and handed out by computing center personnel. The person sorting the printouts saw Sid's tic-tac-toe games and confronted him, saying, "You can't do this. Computers are not for playing games!" She called Prof. Sherman, who fortunately provided assurances that the work was legitimate.

After Sid graduated, personal computers began to emerge and actually lent themselves to making games. Sid's first home computer was an Atari 800, and he started writing games on it for fun. A colleague at his day job, Bill Stealey, became interested in starting a company around games and Sid was interested in making them, so in 1982 the two formed MicroProse.

At MicroProse, Sid and Bill's philosophy was to develop games that they would enjoy playing, which led them in the direction of developing strategy and simulation games as opposed to arcade games. As the game industry evolved, a new genre of "building games" developed, which was characterized by the release of Sim City in 1989 and MicroProse's release of Railroad Tycoon in 1990. The success of these games inspired Sid's team to think really big and they came up with the idea of a game based on the history of civilization, which led to the game Civilization in 1991. Civilization leveraged a universal sense of history and introduced familiar elements to create an experience that was fun and empowering. It resonated at the time, and continues to be one of the most recognized game franchises today (Civilization V was released in 2010).

In the early 1990s, MicroProse was acquired by Spectrum Holobyte. Sid left in 1996 to cofound Firaxis, where he is today Director of Creative Development. It has been 30 years since Sid began developing commercial games, and in that time he has developed, co-developed, or produced over 40 titles, an astonishing accomplishment. His name, which precedes the titles of so many of Firaxis' games, is a household word amongst gamers, and in 2011 the people search company PeekYou claimed that Sid has the largest digital footprint of any game developer.

In recent years, Sid has renewed ties with the department and donated his time and energies to activities here. It began when his son Ryan enrolled at Michigan to pursue a CS degree and a career in game development (Ryan graduated in December 2011 and is working at Blizzard Games). Sid has come back to judge game development competitions, speak at classes, and recently ran a 12-day workshop for aspiring game developers. May the games never end!

Notable Industry Recognitions:

2009: Number two, IGN's list of Top Game Creators of All Time.

2008: Lifetime Achievement Award at the 2008 Game Developer's Conference.

1999: Second person to be inducted into the Academy of Interactive Arts and Science Hall of Fame.

1996: Number one, GameSpot's Most Influential People in Computer Gaming of All Time.

1996: Number eight, Computer Gaming World's Most Influential Industry Players of All Time.

Alumni Spotlight

W. David Tarver

Building a Successful International Company was his Proving Ground

W. David Tarver
BSE MSE EE '75, '76

"I wanted to prove that I could do this."

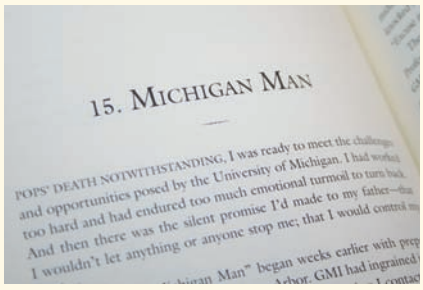
"This" was starting his own company – a dream formed when David was in high school working hard to win the Flint Area Science Fair in Flint, Mich. A second place win only fueled his determination.

William David Tarver, born in 1953, has vivid memories of certain incidents in the civil rights movement which, he stated, "made me acutely aware of race and the limitations placed on my father's generation. I wanted to prove that a new day had come."

After high school, David attended General Motors Institute (GMI) – a special program that gave him a free education and allowed him to work at the same time. While there, he walked in on a MOOG electronic music concert. Fascinated by the combination of art and engineering, he decided to build his own music synthesizer.

He continued work on the synthesizer after transferring to Michigan. "In my bedroom I had a lab table with an oscilloscope and all the circuits that I was building for this digital electronic music synthesizer. It became my master's thesis."

His advisor at Michigan was Prof. Leo McAfee, the first African American faculty member hired at the College of Engineering. Upon graduation, David accepted a position at the famous Bell Telephone Laboratories (Bell Labs), widely regarded as the place where the leading scientists of the day did their research.


15. MICHIGAN MAN

POPS' DEATH NOTWITHSTANDING, I was ready to meet the challenges and opportunities posed by the University of Michigan. I had worked too hard and had endured too much emotional turmoil to turn back. And then there was the silent promise I'd made to my father—that I wouldn't let anything or anyone stop me; that I would control my

"I discovered at Bell Labs a telephone network simulator that had almost the exact same technology as my music synthesizer. This analog device cost $6,000 and it needed a $10,000 device next to it to figure out what it was doing. I thought – if I do a digital version of the device, I can sell it for a lot of money. I decided to build a telephone network simulator, and started to work on the device in my basement with two colleagues from Bell Labs: Steve Moore and Charles Simmons. That became our first product. You could say the groundwork for that first product was laid here at Michigan."

Tarver, W. David.
Proving Ground: A Memoir.
Cypress House, 2012.

David left Bell Labs in 1983 and co-founded Telecom Analysis Systems, Inc. with Moore and Simmons. The company finally moved out of his basement in 1984, and went on to become a successful international firm – with sales in Japan that in some months rivaled and even surpassed U.S. sales.

When he sold the company in 1995 to Spirent (then Bowthorpe) for $30M, he took a moment to reflect on the fruition of his boyhood dream. He did it. David recalled, "The day I sold the company it really hit me that I could do what I wanted – I felt free."

He continued to work at Spirent for an additional four years, becoming president of the telecommunications business unit. In this capacity, he spearheaded development of a business that achieved sales of more than $250 million and a market value in excess of $2 billion.

For David – leaving the company in 1999 was not the end of the story – just the beginning of a new chapter. He became a community organizer, and helped raise the test scores of 8th grade students in Red Bank, NJ from a paltry 25 percent passing rate in 2001 to more than 60 percent in 2005.

In addition to community support, he knows it also takes resources to support a top notch education – resources that many lack. To honor the sacrifices made by his parents, and to open opportunity to undergraduate students, he established the Fred and Louise Tarver Scholarship Fund.

David singing Stevie Wonder's "I Wish" at the Tallulah Bar & Grill in Birmingham, Mich.

David recently moved back to Michigan with his family. Those fortunate to attend his book signing party in Birmingham, Michigan in late May heard firsthand his strong clear jazz tenor voice – yet another of his many talents! His book, *Proving Ground: A Memoir*, offers inspiration and encouragement to anyone with a dream, and the determination to make their dream a reality.

Alumni Spotlight

Richard P. Wallace

Reaching New Heights

President and CEO, KLA-Tencor Corporation
BSE EE 1982 (Also: MS, Engineering Management, Santa Clara University, 1989)

Whether it's biking to the crest of Haleakala on Maui, or leading KLA-Tencor to the top of NASDAQ, Rick Wallace is familiar with making it to the summit. His goals were set by the age of 6, when he knew he wanted to be an electrical engineer, run a company and be an entrepreneur, even though he admits that he scarcely knew what any of that meant.

"It's important to have a passion for what you do"

By the time he started Michigan as an undergraduate student, he had built his own PC – and assumed everyone else had done the same. "I grew up with oscilloscopes in my basement," said Rick. "I was a ham radio operator. I just had a passion for electronics."

Rick's first job as a Michigan alumnus was at P&G, followed by the startup company Cypress Semiconductor in Silicon Valley. He said he got a job working in their cleanroom because "I had an EE degree from Michigan, and I was a photographer." While at Cypress he learned about a product from KLA Instruments, a company that specialized in semiconductor equipment, and became passionate about it. "It had optics, it had engineering, it had image processing – all things I was interested in," he said.

He also spent his mornings and evenings getting a master's degree from Santa Clara University – motivated by his desire to understand how semiconductors were really made. Once there he switched his major to engineering management, and upon graduation continued to teach a course in global competitiveness for five years.

In 1988 he joined KLA, which merged with Tencor Instruments in 1997 to become KLA-Tencor, and never looked back.

Fat Cats Don't Hunt

In the early years, Rick became familiar with various parts of the company by working on and managing projects in different areas. At one point, he was looking for a greater challenge and accepted the goal of starting a new business within KLA. He hired a team member and had 90 days to come up with a business plan.

They discovered a new $20M business product that likely would have been lost to KLA had they not been searching for an unmet need in the industry. Wondering why they didn't see the opportunity sooner, his partner simply stated – fat cats don't hunt. Rick says this experience taught him the value of focus and full-time dedication to new initiatives.

President and CEO

Rick became president and CEO of KLA-Tencor in November 2005, and since then the company has continued its upward trajectory.

In the past couple years, KLA-Tencor has blown away Wall Street predictions. In one phenomenal quarter, KLA was beat out only by Apple in earnings. He attributed the gain to the mobility market – smart phones and tablets, including e-readers. "It's just on fire," he said in one of the many interviews he granted to the news media at the time.

The desire for mobility has led to a leap in the demand for higher performance combined with increased battery life – all in a small device. One of the effects on the semiconductor industry is an increase in the number of semiconductor fabrication facilities being planned – from 1-2 a couple years ago, to 13 today. These are $4B facilities, and making them profitable is KLA's specialty. These days, the company's high-end tools cost upwards of $35M, each.

"Keep learning new things"

Lasting Values

As president and CEO of KLA-Tencor since 2005, and with 24 years in the company, Rick has developed five core values for the company, and the individuals who work there. They must have 1) perseverance, 2) a drive to be better, 3) the ability to work well in high-performing, multicultural, interdisciplinary teams, 4) the willingness to be consistently honest and forthright, and 5) the desire to provide indispensable products and unmatched service for KLA-Tencor's customers.

Alumni Awards

2011 COE ALUMNI MEDAL AWARD WINNER

Peter S. Fuss *(BSE EE '56; also MS EE '60 from New York University)*

David C. Munson, Jr. (Dean, College of Engineering), Peter Fuss.

Peter Fuss received the highest honor awarded by Michigan Engineering alumni for his outstanding professional accomplishments combined with his dedicated support of Michigan's faculty and students. Peter began his career at Bell Laboratories, where he headed the development of digital signal processor systems for submarine detection. He later managed the development of operating system software and processor hardware. After 19 years he joined Teletype Corporation as Director of Research and Development, and led the development of electronic terminal systems, VLSI, and software. In 1979 he joined Tellabs, Inc., a leading manufacturer of voice and data communications equipment, and in 1987, he founded Tellabs International, Inc., a subsidiary of the parent company. Tellabs Int. is responsible for all Tellabs operations outside of North America with sales, R&D, and manufacturing facilities in 24 cities throughout the world. He retired from Tellabs in 1993.

In service to the College, Peter served on the highly successful Progress & Promise: 150th Anniversary Campaign Committee; he chaired the Michigan Engineering Fund, and he has served on the Michigan Engineering Alumni Board and the EECS National Advisory Committee. Peter and his wife Evelyn provided a leadership gift for the construction of the Peter S. Fuss Pavilion on North Campus, and he established a professorship in his name.

Peter holds ten patents, primarily in the area of digital signal processing. He has served on the boards of several technology companies, and he is a special consultant and former executive vice president of technology at Batterson Cross Zakin Venture Partners. Read more about Peter Fuss, and watch a short video online.

2011 COE MERIT AWARD WINNER (ECE)

(BSE EE '81)

David C. Munson, Jr. (Dean, College of Engineering), Syed Ali, Khalil Najafi (Chair, Electrical and Computer Engineering).

Syed Ali is founder, chairman, president & CEO of Cavium, a publicly listed company that provides highly integrated semiconductor processors that enable intelligent networking, communications, storage, video, and security applications to worldwide markets. Founded in 2000, Cavium was named the 5th fastest growing technology company in the United States by *Forbes Magazine* in 2011.

From 1998–2000, he was founding team member and vice president of marketing and sales at Malleable Technologies, a semiconductor company that developed Digital Signal Processors for delivering voice over IP networks. It was subsequently acquired by PMC-Sierra, a communication chip company in 2000. From 1994–1998, Mr. Ali was executive director at Samsung Electronics, where he played a major role in starting and growing Samsung's Flash memory and CPU businesses.

Mr. Ali has also held various positions in product design and development at Wafer Scale Integration (acquired by ST Microelectronics, Italy), Tandem Computer (a division of Hewlett Packard), and American Microsystems Inc. In his homecoming talk to students and faculty, he stressed the importance of an international perspective, flexibility, fearlessness, and optimism. Read more about Syed Ali, and listen to his talk online.

2011 COE MERIT AWARD WINNER (CSE)

Mark Abel *(BSE EE '79)*

Mark Abel is the Associate General Manager of Software Services and Director of Pathfinding at Intel. In his over 20 years at Intel, Mr. Abel's teams have won or shared Intel's highest honor, the Intel Achievement Award, seven times for the creation of new technologies and new businesses for Intel, including the invention and delivery of technologies that have shipped in over a billion PCs.

Before joining Intel in 1991, Mr. Abel held research and leadership positions with Bell Labs, Xerox PARC, US West Advanced Technologies, and Siemens. He is the author/co-author of over 20 journal and conference papers including several frequently cited works in the Computer Supported Cooperative Work literature.

As Intel's executive sponsor for U-M since the mid-1990s, Mr. Abel has been an active sponsor and advisor to the University, the College of Engineering, the EECS department and many U-M professors and students. He has served as an early and ongoing member of the EECS Alumni Association board, as an advisor to successful U-M startup Arbor Networks, Inc., as a member of the School of Information Advisory Board and as a member of the College of Engineering Advisory Committee.

David C. Munson, Jr. (Dean, College of Engineering), Mark Abel, Marios Papaefthymiou (Chair, Computer Science and Engineering).

In his homecoming lecture, Mr. Abel described the life events that led to his decision to be an engineer and computer scientist, and the incredible things that followed.

1980's

Stephanie Forrest Receives Newell Award

U-M Computer and Communication Sciences PhD alumna **Stephanie Forrest** (MS, PhD, CCS '82 '85), Professor of Computer Science at the University of New Mexico in Albuquerque, received the 2011 ACM/AAAI Allen Newell Award in recognition of her fundamental, paradigm-changing contributions to computer science and the biological sciences, most notably for bringing together models of immune systems, automated diversity, and network epidemiology, with significant impact on real computer and biological systems research and practice. The Newell Award recognizes an individual for career contributions that have breadth within computer science, or that bridge computer science and other disciplines.

Barracuda Networks Grows, Expands in Ann Arbor

Dean Drako (BS EE, 1987) founded Barracuda Networks in 2003 to provide network security services. The company, based in Campbell, Calif., rapidly grew into a global entity with hundreds of employees that offers a range of network, backup, and data protection services. In 2007, Barracuda was struggling to attract the software engineering talent that it needed to continue growth and made the decision to open an engineering office in Ann Arbor near U-M. The local office opened with eight employees, and has since grown to 180 employees and become the company's central engineering site. In June 2012, Barracuda announced that it would relocate its Ann Arbor operation to the former Borders headquarters location on Maynard Street in downtown and expects to add another 200 software engineering jobs.

1990's

Steven McLaughlin (PhD EE '92) was named the new Steve W. Chaddick Chair of the School of Electrical and Computer Engineering at Georgia Tech. Most recently he served as vice provost for International Initiatives and as Steven A. Denning Chair in Global Engagement at Georgia Tech. He is a co-founder of Whisper Communications, established in 2009. The company states that their Cone of Silence technology is designed to prevent eavesdroppers from collecting any information in the wireless/mobile payment point-of-transaction.

Craig Labovitz and Joe Eggleston, co-founders of DeepField.

Former Arbor Networks Leaders Launch New Ann Arbor-Based Cloud Data Company

Computer science alums **Craig Labovitz** (MSE CSE '94, PHD CSE '99) and Joe Eggleston (BSE CE '98 ENG, MSE CSE '99) have launched DeepField, a new Ann Arbor-based startup that analyzes big data from the cloud to help content providers and carriers make smarter business decisions. The two founders had both been at EECS tech transfer spinout Arbor Networks for approximately 10 years in spring 2011 when they left to found DeepField.

"The problem we have identified is that everything is changing in the way companies build stuff on the Internet. The Internet, together with the cloud, are the most complicated thing ever built in human history," said Labovitz, who is CEO of DeepField. DeepField was created to help companies see how all of various pieces of their online presence fit together and to achieve maximum efficiency and profitability.

When the company's launch was announced at the end of July, the venture already had a base of paying customers and private beta users, including major Internet companies, although the names of customers are currently embargoed. DeepField is venture capital funded and has investors that range from a fund in Houston, Tex. to RPM Ventures in Ann Arbor.

DeepField is housed Ann Arbor's Tech Brewery business incubator and plans to continue building the company here in Ann Arbor. According to Labovitz, they are finding great, well-prepared talent from the Department and University.

Jason Heltzer (BS CS '96) has been named a General Partner at the venture capital firm OCA Ventures. He has also been appointed as an adjunct assistant professor of entrepreneurship at the University of Chicago Booth School of Business. He lives in Chicago with his wife Wendy and sons Gideon, Miles and Arlo.

1990's

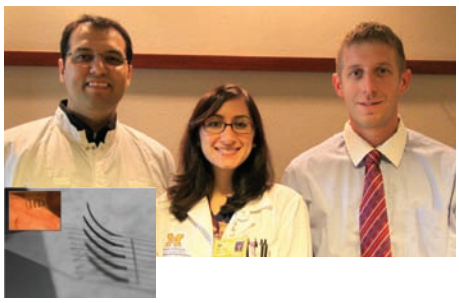
Duo Security founders Song and Oberheide.

Duo of CSE Alums Form and Grow Security Company in Ann Arbor

Serial entrepreneur **Dug Song** (CS BS 1997) and recent alum **Jon Oberheide** (CSE PhD 2011) founded security firm Duo Security in early 2010 and have rapidly grown their company to serve over 500 customers in 40+ countries around the world as of mid 2012. Duo Security provides hosted two-factor authentication service, which is technology that enables users to secure their logins and transactions using smartphones to prevent fraud and account takeover. The company is located in Ann Arbor's Tech Brewery business incubator, and the majority of the firm's employees are U-M alums.

Duo Security is poised for additional rapid growth, having received a $5M Series A round early in 2012 led by Google Ventures and True Ventures to continue to grow the company in Ann Arbor. The company joins security industry heavyweights Arbor Networks — co-founded by Prof. Farnam Jahanian and G. Robert Malan (MSE PhD CSE '96 '00) and at which Song previously served as Chief Security Architect — and Barracuda Networks (founded by Dean Drako, BS EE, 1987) as the third in a trio of security firms with U-M roots and a strong presence in Ann Arbor. We feel safe!

2000's



L: Eugene Daneshvar, Dr. Duna Raoof-Daneshvar, Steve Koski

Eugene Daneshvar (BSE EE '05) is CEO and co-founder of SynapTech, a new startup company that specializes in the design, fabrication, and development of movable microelectrode arrays for neural interfaces. The company was launched in 2011, after winning the National Collegiate Inventors and Innovators Alliance (NCIIA) E-Teams Business competition for their technology focused on treating blindness. That same year they were awarded tenancy in TechArb, the local student business incubator. The other team members of SynapTech all have EECS or Michigan ties. Steve Koski (BSE EE '04) is in charge of business development and marketing for the company. Dr. Duna Raoof-Daneshvar is the chief resident physician in ophthalmology at U-M's Kellogg Eye Center, and she also received her undergrad and medical degrees from U-M. Eugene is currently pursuing his doctoral degree in biomedical engineering, and is working on characterization of electroactive polymer actuators in Prof. Khalil Najafi's lab.

Jon Oberheide Named One of 30 Under 30 in Technology by Forbes

Jon Oberheide, CSE PhD 2011, was named one of 30 leading young innovators in the technology space by Forbes for his work in mobile security. Oberheide has established strong credentials in the security space: while previously working as a PhD student in Prof. Farnam Jahanian's security group, Oberheide exposed a number of critical vulnerabilities in the Android operating system that affected hundreds of millions of handsets.

Aminur Rahman (BSE EE '12) is CEO of the company Invisi-Tag, which he founded while still an undergraduate student. The company specializes in mobile RFID asset management using custom RFID Hardware and Software. Invisi-Tag has combined their unique system with smartphone/tablet capabilities (i.e. Samsung Galaxy, Google Nexus S, Nexus 7) which will allow the user to view all their information right at their fingertips. While the technology can be adapted to any market, initially the company targeted the landscape industry. More recently they are adapting their technology to the restoration industry.

Steve Hechtman (BSE EE '09), former project manager and driver on the U-M Solar Car team, is currently working at the Johns Hopkins University Applied Physics Lab on the Stratospheric Terahertz Observatory (STO). As part of his work on this NASA Long Duration Balloon project, he traveled to the Southern Hemisphere via New Zealand and Australia before ending up in Antarctica. When he disembarked from the plane, he was treated to a spectacular view of the surrounding mountains.

Donor Spotlight

Ernest S. Kuh

ECE Distinguished Faculty Scholar Award Established

Khalil Najafi (Chair of Electrical and Computer Engineering), Ernest Kuh, Anthony Grbic, Bettine Kuh, David C. Munson, Jr. (Dean of the College of Engineering)

Prof. Anthony Grbic (back row center) and members of his research group.

Alumni Giving Back: Ernest and Bettine Kuh Distinguished Faculty Scholar Award

At the heart of our activities in EECS is the research and teaching of our distinguished faculty, who spend countless hours preparing and teaching courses to undergraduate and graduate students. In addition, they manage small to very large research groups comprised of graduate students and occasionally undergraduate students. Their quest for innovation and knowledge lead them to develop the theory and technology that is positively impacting the world we live in.

Recognizing the tremendous impact of faculty on the lives of students, and on the future of science and technology, Ernest and Bettine Kuh endowed the Ernest and Bettine Kuh Distinguished Faculty Scholar Award. This award is bestowed on an outstanding young faculty member in the Electrical and Computer Engineering Division on the basis of teaching, research, and service, as well as on their record of innovation, leadership, and citizenship. The award and its title will rotate every two years.

The first recipient of this award is Prof. Anthony Grbic, an outstanding young faculty member who is already making an impact in the areas of applied electromagnetics, most recently in the areas of metamaterials and printed antennas. He has already received many awards, including the Presidential Early Career Award for Scientists and Engineers (PECASE).

"I'm honored to receive the award," said Tony, "and grateful to Prof. and Mrs. Kuh for establishing this timeless gift."

Prof. Ernest S. Kuh is a highly distinguished alumnus of the department and one of the preeminent scientists in the field of electrical engineering. He specialized in electrical circuit theory and computer-aided design for very-large-scale integration (VLSI) circuits and systems, and is considered one of the fathers of electronic design automation (EDA).

He earned his bachelor's degree in electrical engineering at U-M, his master's degree from MIT and his PhD degree from Stanford University. After working at Bell Labs, where he met many of the foremost scientists of his time, he joined the faculty at UC-Berkeley in 1956. He is the William S. Floyd, Jr. Professor Emeritus at Berkeley, where he served as faculty member, Department Chair, and Dean of the College of Engineering until his retirement in 1993.

Dr. Kuh wrote widely-used textbooks on circuit theory and synthesis. He was inducted into the Silicon Valley Hall of Fame in 2008 and has received numerous additional awards and honors, including the EDAC Phil Kaufman Award, the IEEE Education Medal, the Kirchhoff Award, and the ASEE Lamme Medal. He is a fellow of IEEE and AAAS, and a member of the National Academy of Engineering.

Prof. Kuh presented a special lecture for faculty and students during his and Bettine's recent visit to Michigan. He talked about the evolution of the field and offered personal anecdotes of many of his contemporaries who, like him, helped define their generation. In attendance were several family members, including a grandnephew who is currently an undergraduate student in the department - Go Blue!

Donor Spotlight

J. Robert Beyster

Computational Innovation Fellows Program Established

Philanthropist J. Robert Beyster is a four-time U-M alumnus and founder of the largest employee-owned research and engineering firm in the United States, Science Applications International Corporation (SAIC). In Feb 2012, the University announced that Dr. Beyster had made a gift of $15 million to the College of Engineering. That gift included the largest sum dedicated to fellowships in the college's history.

The newly established J. Robert Beyster Computational Innovation Graduate Fellows Program will support students in fields that link high-performance computing to applications with real-world impact. That could include research in bioinformatics, mobile computing, network security, renewable energy materials, advanced imaging and stealth technologies, nuclear reactor safety, and robotic systems for automotive safety and military vehicles, among other areas.

The University of Michigan has been important to Dr. Beyster and his family for generations. His father was a graduate of the College of Engineering. When Dr. Beyster was a child, he and his family spent many weekends at U-M, visiting his aunt, Jessie Bourquin, who studied landscape architecture and went on to own a prominent Michigan business in the field.

After graduating high school in Trenton, Mich., in 1942, Beyster joined the Navy and attended U-M through the V-12 College Training Program. He received bachelor's degrees in engineering physics and engineering math in 1945. He earned his master's and doctoral degrees in physics at U-M in 1947 and 1950, respectively.

"I hope that the research my gift will support will help keep the United States at the forefront of global innovation and competitiveness," Dr. Beyster said. "I believe that the

combination of capital improvements, fellowships and research I am funding will provide the right environment for this to take place."

Dr. Beyster has a history of giving to Michigan Engineering. In recent years, he has contributed toward research in biofuels, cloud computing and security, and gene therapeutics. He has also funded a class on employee ownership though the Center for Entrepreneurship.

In recognition of his most recent gift to the College, the Computer Science and Engineering Building has been named the Bob and Betty Beyster Building.

ARBOR NETWORKS

Arbor Networks Fellowship Established in CSE

With the sale of Arbor Networks, the successful network monitoring and security services company co-founded by Farnam Jahanian, the Edward S. Davidson Collegiate Professor of Electrical Engineering and Computer Science, an Arbor Networks Fellowship has been established in the CSE Division to support a graduate fellow every year. The fellowship was was made possible by an endowment of close to $500,000 to the CSE Division, which represents the value of a portion of the University's stake in Arbor. The return of these funds to CSE was agreed upon when Prof. Jahanian negotiated with Technology Transfer for the license to the IP that formed the basis for Arbor. The Division is grateful to Prof. Jahanian for his foresight and extraordinary commitment in having made this arrangement when he built his company.

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The Department thanks the donors named below as well as those who gave anonymously during the past year. Your support is essential in keeping the Department strong and ensuring that the best students attend Michigan to receive the education they deserve.

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Jorge L. Aravena ('80; 9/17/2010)

Thomas M. Wall ('85; 8/8/2011)

CLASS OF 2000-09

Meaza Teshome ('00; 5/9/2011)

Homecoming in EECS

Friday, October 12, 2012

11:00 am EECS Merit Award Winner Talk

12:00 pm LUNCH in the Beyster Building

1:30 pm EECS Merit Award Winner Talk

Saturday, October 13, 2012

Michigan Engineering Tailgate

Football Game: U-M vs. Illinois

Our Merit Award Winners for 2012

Krisztián Flautner
BSE MSE PhD, CSE '96 '98 '01
VP for R&D
ARM Inc.

Daniel Moloney
BSE EE '81
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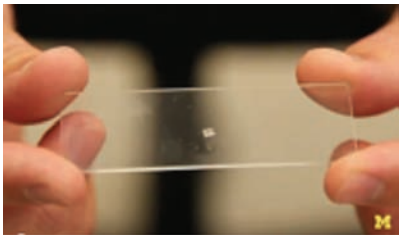

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