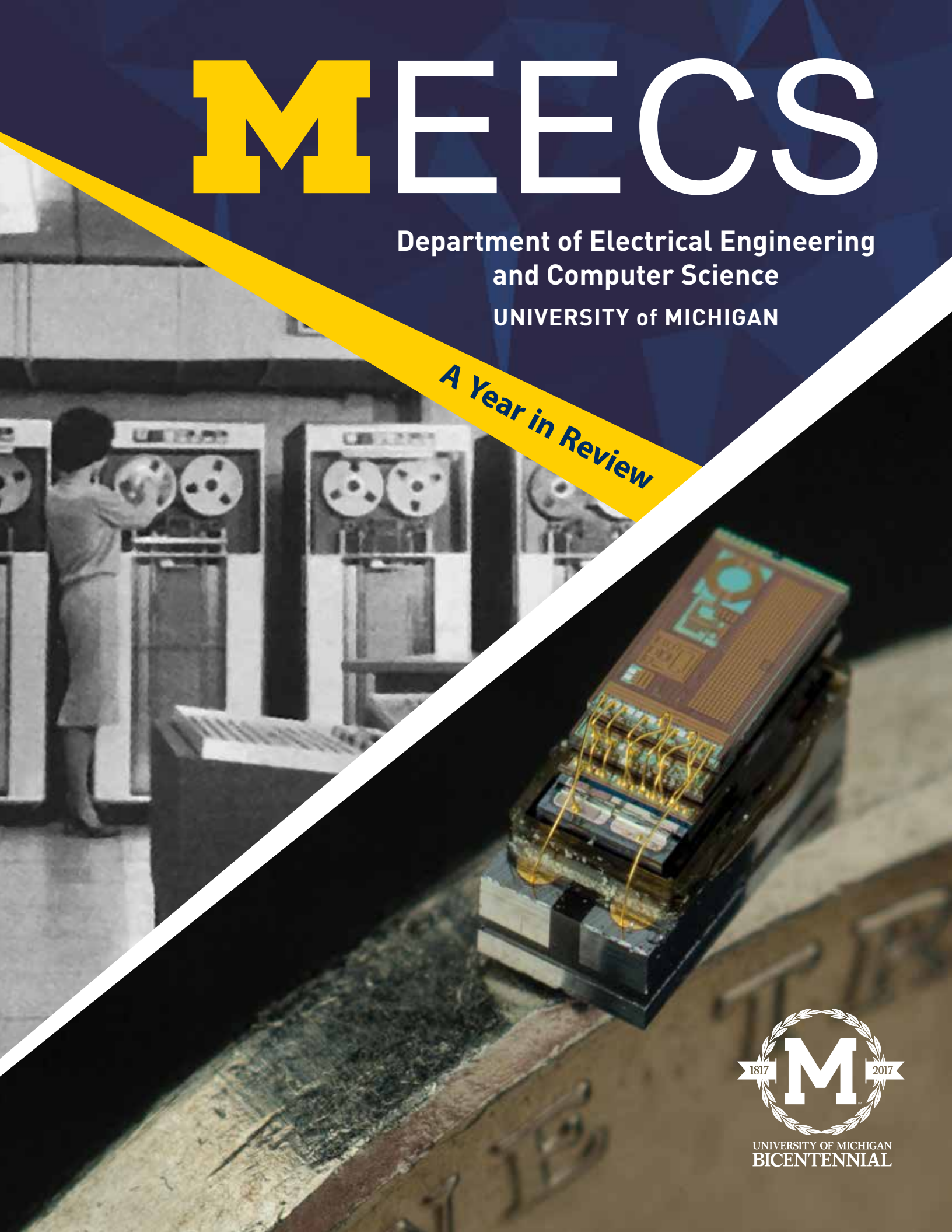
MEECS

Department of Electrical Engineering and Computer Science

UNIVERSITY of MICHIGAN

A Year in Review



1817 2017

UNIVERSITY OF MICHIGAN
BICENTENNIAL

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Department of Electrical Engineering and Computer Science

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MESSAGE FROM THE CHAIRS

Khalil Najafi, Chair
Electrical and Computer Engineering

Brian Noble, Chair
Computer Science and Engineering

Dear Alumni, Students, and Friends,

As the world continues to change before our very eyes, our leadership is changing as well! We have a new chair of Computer Science and Engineering (CSE) to lead our faculty and students in that division. Brian Noble started his tenure July 1, 2017, and looks forward to leading CSE into the future. And by this time next year, we will have welcomed a new chair in Electrical and Computer Engineering (ECE) as Khalil Najafi completes a decade of service to the ECE community.

We hope you notice something different about this year's newsletter – it's a historic difference! 2017 marks 200 years since the founding of the University of Michigan in 1817. A small sample of the people and discoveries that have helped shape the department and society are sprinkled throughout the newsletter.

Many of the research breakthroughs of the past are current areas of investigation today. For example, in 1981, our faculty received funding to develop a micromachined neural probe. That probe was successfully built and distributed to researchers around the world. Steady progress in neural research has continued unabated, and Michigan was recently named an NSF NeuroNex Technology Hub for the project, Multimodal Integrated Neural Technologies (MINT).

The late Arthur Burks, first chair of the Computer and Communications Science Department in the 1960s, was involved in creating the first general purpose programmable computer, called the ENIAC (Electronic Numerical Integrator and Computer). Part of that computer can be seen here in the Beyster Building. Today one of the biggest concerns in modern computing is security – and we have some of the top people in the field working to both uncover and mitigate existing weaknesses while also designing future computers that will be more secure from malicious attacks.

Our department has changed dramatically since the early years in electrical engineering and computer science. Did you know that the same ten faculty ran the department during a period of 16 years, from 1926 to 1942? The Depression years were tough on everyone, and throughout the 1930's, only seven doctoral degrees were awarded. Today, the department has more than 140 faculty, 1,880 undergraduate students, and nearly 1,100 graduate students.

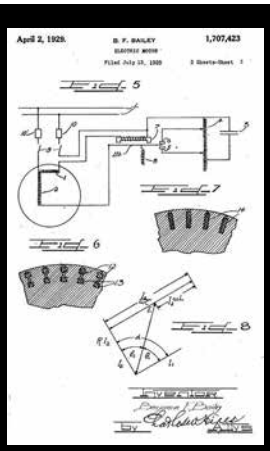
In this year's issue of *EECS News*, we expanded coverage of our students, including their participation on various interdisciplinary student teams. Whether helping teams cross the finish line first, establishing brand new teams, starting companies, or finding fellow musicians to jam with, our students continue to amaze us with their leadership and ingenuity.

Our alumni are the best in the world. Read about some of our past and current alumni and remember to get connected and stay connected! We'll continue to try to make that easier and easier.

In this year of the Michigan Bicentennial, we may take a moment to take pride in our past – but then it's back to business! After all, with connected vehicles, automation, computer security, big data, medical devices, and energy & sustainability in our wheelhouse, the future is in our hands – and we aim to make it bright!

{1925} BENJAMIN BAILEY

Benjamin Bailey (BSE MSE PHD EE 1898 1900 1907), who studied by kerosene lamp as a student, chaired the department for a record 22 years between 1922-1944. He was a prolific inventor, and invented the single-phase capacitor motor in 1925. He spent much of the money from his patents on laboratory equipment, having served as chair during the Great Depression. He was honored as a Modern Pioneer in the American Frontier of Industry in 1940, along with Henry Ford, inventor of the Model T.



Patent for single-phase capacitor motor

Benjamin Bailey

Photo courtesy Bentley Historical Library

Research

BRIEFS

New Tool to Study Cancer

Prof. Euisik Yoon and his team developed a device that can trap more than 10,000 cancer cells in a single chip for individual study. This is important because it turns out that not all cancer cells are the same. One theory holds that only one to five percent of the cells in a tumor are cancer stem cells.

This technique could one day help determine potential cancer treatments based on an individual patient's tumor and help researchers better understand so-called cancer stem cells. It also sheds light on a controversy: are large cells or small cells more likely to be cancer stem cells?

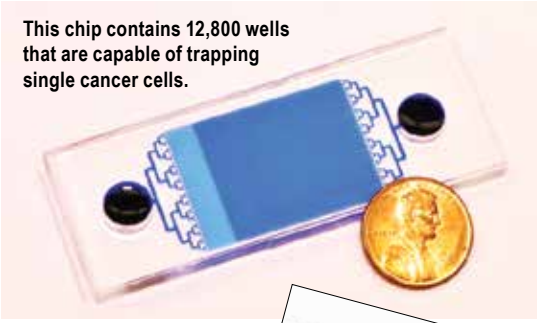
"Most normal cells will die if they are not anchored to something, but cancer stem cells can survive. They can become circulating tumor cells and come to another area of the body," said Euisik Yoon, professor of electrical and computer engineering and also biomedical engineering.

Their technique runs cancer cells through a device not much wider than a quarter that contains 64 branches, each of which has 200 chambers for capturing individual cells. The cells are then ready to be studied.

It turns out that a cell that can't metastasize will die in a few days, while a cancer stem cell will start growing. Other devices have been developed to capture cancer cells, but the cells then have to be manually recorded. Yoon's team developed a special computer algorithm that automatically combs through the microscope images and assesses the size and number of cells in each well, even when the images in the microscope are rather dim.

"Our method is special because we really want to enable the study of many cells at once," said doctoral student Yu-Heng Cheng. "Cancer cells have many different appearances, and our algorithm recognizes them. With this tool, experiments will be faster and easier, so we could screen many, many cell lines."

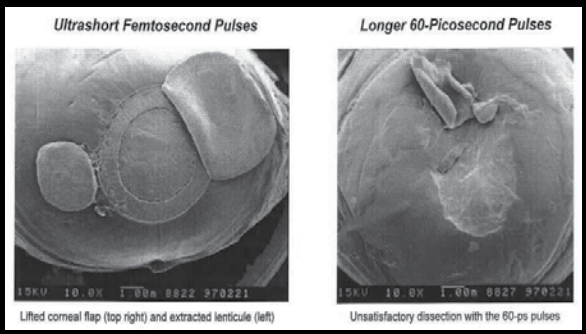
The team tested actual cancer cells from four women with breast cancer who were treated at the U-M Comprehensive Cancer Center.



This chip contains 12,800 wells that are capable of trapping single cancer cells.

The research was featured on the cover of *Lab on a Chip*, issue 19, 2016.

{1997} BLADELESS LASIK SURGERY



Lifted corneal flap (top right) and extracted lenticule (left)

Unsatisfactory dissection with the 60-ps pulses

A femtosecond is almost unbelievably fast, lasting only 10^{-15} seconds. Researchers in the Center for Ultrafast Optical Science (CUOS), founded by Gérard Mourou in 1990, specialize in such ultra-fast pulses of light, and in the early 1990's were pioneering medical applications for femtosecond lasers. With the discovery that these lasers made precise cuts without damaging surrounding tissue, even in the eye, bladeless lasik surgery was born. Dr. Ronald Kurtz and CUOS researcher Dr. Tibor Juhasz founded IntraLase in 1997 to bring this technology to all.

Stopping the Spread of Cancer

In related research, Yoon's group developed a microfluidic chip that can capture rare, aggressive cancer cells, grow them on the chip, and then release single cells on demand. This allows researchers for the first time to easily compare two different "sister" cells, meaning cancer cells that grew from the same cancer cell.

The ultimate goal of the project is to find out what drives the "self-renewal" processes that enable aggressive cancer cells to behave like stem cells. These so-called cancer stem cells are capable of dividing and turning into different kinds of cancer cells with unique genetic profiles. Cancer researchers believe that if certain stem-like properties can be switched off, the cancer will not be able to grow and spread. Studies with the new chip could also reveal why some cancer cells are resistant to drugs.

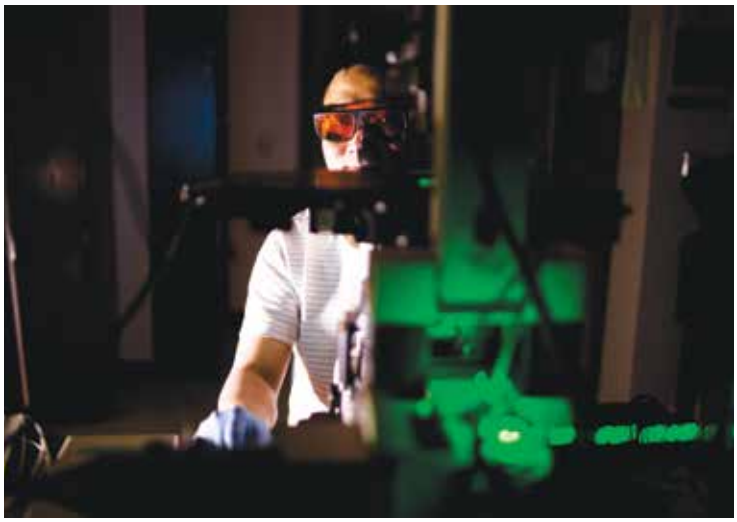
"When a tumor forms, some cancer stem cells maintain stemness, while others are differentiated," said assistant research scientist Yu-Chih Chen. "By understanding this, we will know more about tumor formation and discover ways to inhibit it."

Most existing methods for freeing individual captured cancer cells are either damaging to the cells or incapable of getting them out of the chip reliably. The Michigan laser was precise enough that it could detach one side of a cell, leaving the other side anchored.

And the bubble detachment process was so gentle that even surface proteins on the cell membrane were unscathed. The surface proteins are an important nondestructive avenue for identifying cancer stem cells.

The task ahead of cancer researchers, with the help of the new chip, is to identify which genes are critical to a cancer stem cell's self-renewing capabilities. If these can be shut down, forcing all cancer stem cells to produce only non-stem cells when they divide, it may be possible to subvert a tumor's ability to grow and spread.

"Some cancer cells are very resistant [to drugs], some are easily killed," said Yoon. "We wanted to take individual cells out after drug screening and look at their genetic profiles to see if we can see what makes cancer cells stem-like."



Yu-Chih Chen, ECE research scientist, helped to develop a chip that can gently release individual cells by targeting them with extremely short laser pulses.

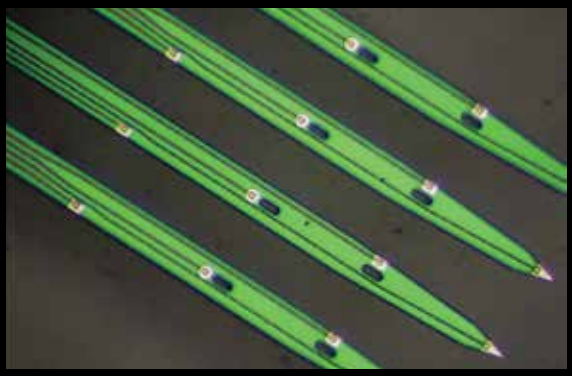
Future experiments could lead to what some cancer researchers call "functional cures," similar to the management of HIV. Stopping the cancer from spreading may be enough to enable a cancer patient to live a healthy life.

Breaking News

$7.75M NeuroNex Tech Hub for Brain Research at the University of Michigan Announced by the National Science Foundation

The NeuroNex hub, called Multimodal Integrated Neural Technologies (MINT), is based at Michigan and involves faculty in Electrical and Computer Engineering, Biomedical Engineering, Michigan Medicine, and New York University. Prof. Euisik Yoon is project director. Read more on the website.

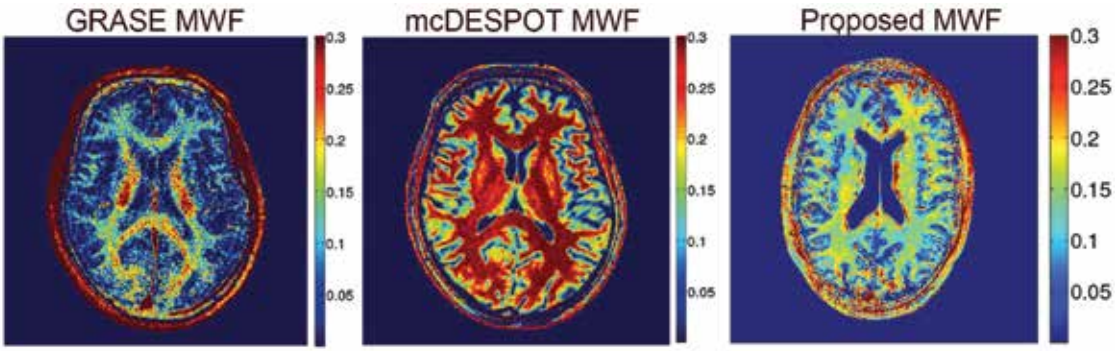
{1994} MICHIGAN PROBE



In 1981, Prof. Kensall Wise and key collaborators David Anderson and Spencer BeMent received funding to develop a micromachined neural probe capable of measuring and influencing activity in the brain at the cellular level. Through the development of these probes, researchers could simultaneously record from neighboring neurons while also distinguishing their individual signals, helping them piece together how neurons form electrical circuits in the brain. In 1994, these "Michigan Probes" were disseminated to researchers around the world, helping to change research directions in the neurosciences.

UNIVERSITY OF MICHIGAN BICENTENNIAL

Big Data Techniques May Transform Quantitative MRI



The three images shown at left reflect two existing methods of medical imaging, and one (right) developed by Michigan researchers, to diagnose multiple sclerosis (MS). The images are attempting to track the myelin water fraction (MWF), a key in the diagnosis and tracking of MS. The proposed method processed the data as quickly as the fast yet unreliable mcDESPOT method, and as reliably as the gold-standard GRASE method.

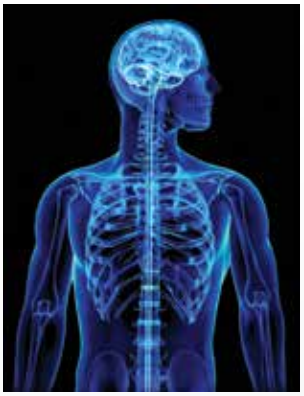
Prof. Jeff Fessler, his student Gopal Nataraj, and biomedical engineering research scientist Jon-Fredrik Nielsen have turned to big data techniques in an attempt to completely transform the field of quantitative magnetic resonance imaging (QMRI).

MRI is a safe, non-invasive, and flexible tool that is used to help diagnose neurological disorders and autoimmune diseases such as multiple sclerosis and Alzheimer's disease. It can also detect biomarkers that indicate elevated risk for a variety of additional disorders, including strokes.

QMRI has the potential of improving the sensitivity of an MRI to a specific disorder while also increasing a doctors' ability to distinguish closely-related disorders. However, qMRI needed to be improved before being feasible for wide adoption. Using an approach borrowed from big data techniques, the researchers proved that they could use qMRI to achieve results quickly, safely, and reliably – making it more likely to be adopted by the medical community.

The research earned Gopal a Best Student Paper award for the paper, "Dictionary-Free MRI Parameter Estimation Via Kernel Ridge Regression," at the 2017 IEEE International Symposium on Biomedical Imaging. The paper was co-authored by his advisors, Jeffrey Fessler and Jon-Fredrik Nielsen, a biomedical engineering research scientist.

A Step Closer to Seeing Through the Body With Visible Light

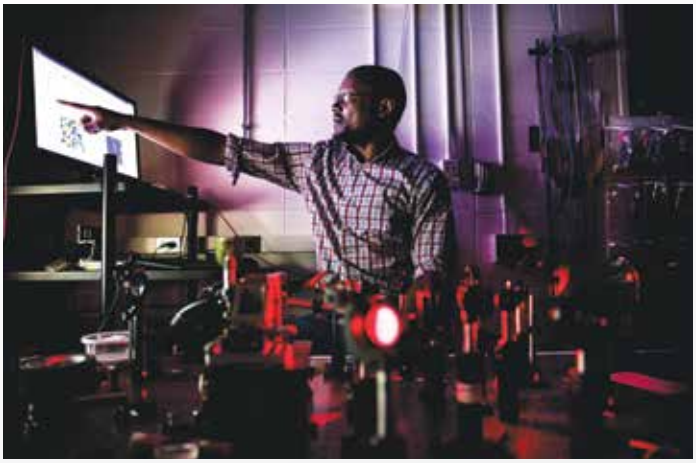


With yogurt and crushed glass, ECE researchers have taken a step toward using visible light to image inside the body. Their method for focusing light through these materials is much faster and simpler than today's dominant approach.

Visible light would be safer for diagnostic imaging than higher-energy x-rays, but is easily scattered.

"Light comes in, it hits a molecule, hits another, hits another, does something really crazy, and exits this way," said Moussa N'Gom, assistant research scientist. N'Gom is working with Profs. Raj Nadakuditi and Ted Norris to understand exactly how a patch of skin scatters light. They have been working to carefully pattern light beams so that they focus inside the body—a first step toward seeing into it.

In their experiments, the researchers spelled "MICHIGAN" with a beam of light shone through yogurt and crushed glass. They chose those materials because they scatter light strongly and serve as good models for skin. Their demonstration, reminiscent of writing a name with a flashlight, shows that they can take a single, quick scan of the material and focus through it at many points—as they would need to do if imaging tissue inside the body.



Moussa N'Gom points to a display showing how the yogurt scatters light. He hopes that the speedy algorithm developed by his team is another step toward medical imaging that can see through skin with visible light.
Image credit: Joseph Xu, Michigan Engineering

N'Gom anticipates that we may see the first visible light images taken through skin within the next five years.

Security

Open Ports Act as Security Wormholes Into Mobile Devices

Computer science researchers have for the first time characterized a widespread vulnerability in the software that runs on mobile devices which could allow attackers to steal contact information, security credentials, photos, and other sensitive data, and also to install malware and to perform malicious code execution which could be used in large-scale attacks.

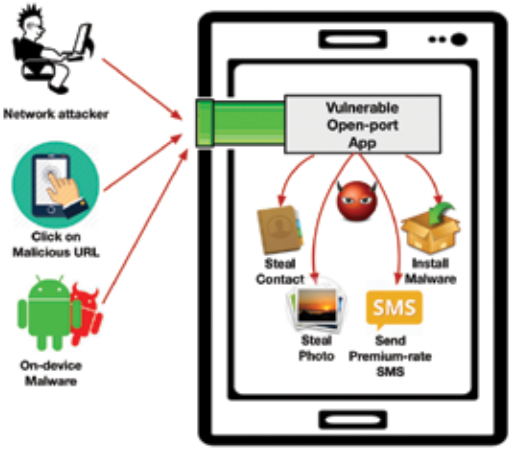
According to the research team of Yunhan Jack Jia, Qi Alfred Chen, Yikai Lin, Chao Kong, and Prof. Z. Morley Mao, the unguarded use of open Internet ports in application software, which are intended to provide the functionality for computer programs to accept packets from the Internet, can be exploited to create security "wormholes" into mobile devices.

The vulnerability is most pronounced in Android apps that allow users to share data across devices and connect to their phones from their computers.

The team identified 410 apps with dangerous insecurities, and 956 different individual ways those insecurities could be exploited. Beyond these figures, they manually confirmed vulnerabilities in 57 applications, including popular file transfer mobile apps with 10 to 50 million downloads. Overall, the number of mobile devices at risk could turn out to be higher, as the researchers continue to investigate how open ports are used in mobile devices.

Open Ports and Their History

Open ports are integral pieces of Internet infrastructure that allow computer programs to accept packets of information from remote servers. These communication mechanisms are routinely used in traditional computers, where they're secure in part because computers' Internet Protocol (IP) addresses don't change. An IP address identifies a connected device.



Open Port Attack Vectors and Targets

Smartphones also rely on open ports to receive certain types of information. But because of the way mobile networks are structured, phones' IP addresses can change as they move through the world. This and other factors relating to mobile architecture lead to these vulnerabilities, the researchers say.

The U-M team isn't the first to identify that open ports on mobile devices could be susceptible to hacking. But their systematic study is the first to show how widespread the problem is.

"Even though the security community has been aware of specific instances in which an open port has served as a backdoor, it remained unclear how general the problem is—and what the fundamental causes are," said Prof. Mao.

How They Did It

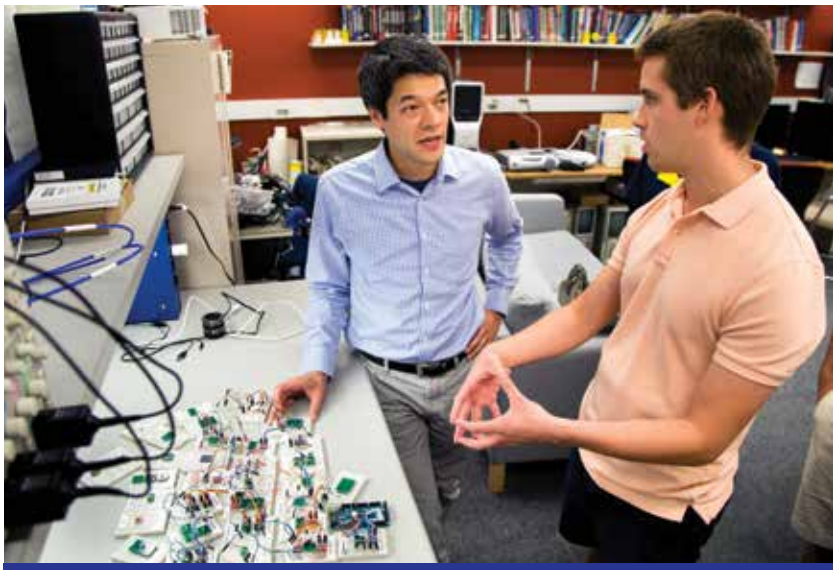
To arrive at their findings, the researchers designed and implemented a tool called OPAnalyzer that can identify and characterize vulnerable open port usage in Android apps. They used the tool to analyze 24,000 popular mobile apps.

They found that more than half of the usage of open ports in the apps they studied were unprotected. While not all of those instances could be exploited to do harm, the researchers say their unprotected nature demonstrates a general lack of awareness of the problem.

The researchers also investigated the fundamental causes behind this general vulnerability, and they found that it is exposed by popular ways open ports are used in the smartphone ecosystem, rather than poor implementation of apps.

The researchers presented a paper on their findings on April 26, 2017 at the 2nd IEEE European Symposium on Security and Privacy, in Paris, France. The paper is titled "Open Doors for Bob and Mallory: Open Port Usage in Android Apps and Security Implications."

SONIC CYBER ATTACKS SHOW SECURITY HOLES IN UBIQUITOUS SENSORS



Prof. Kevin Fu (left), CSE graduate student Timothy Trippel, and their collaborators have demonstrated a way to take control of or influence devices such as smartphones through the use of sound waves.

Research performed by Prof. Kevin Fu, Prof. Peter Honeyman, CSE graduate student Timothy Trippel, and their collaborators at the University of South Carolina calls into question the longstanding computer science tenet that software can automatically trust hardware sensors.

The researchers studied the inertial sensors that are known as capacitive MEMS accelerometers and which measure the rate of change in an object's speed in three dimensions. Embedded into the circuits of airplanes, cars, trucks, medical devices, smartphones, and even emerging satellites, these sensors gather information from the outside world and pass it on to decision-making components on the fly. Accelerometers help airplanes navigate, tell auto safety systems when to deploy, and keep your smartphone screen properly oriented, to name just a few of their jobs.

But it turns out they can be tricked.

Led by Prof. Fu, the team used precisely tuned acoustic tones to deceive 15 different models of accelerometers into registering movement that never occurred. The approach served as a backdoor into the devices – enabling the researchers to control other aspects of the system.

"The fundamental physics of the hardware allowed us to trick sensors into delivering a false reality to the microprocessor," Fu said.

The researchers performed several proof-of-concept demonstrations of what's possible: They used a $5 speaker to inject thousands of fictitious steps into a Fitbit; they played a malicious music file from a smartphone's own speaker to control the phone's accelerometer trusted by an Android app to pilot a toy remote control car; and they used a different malicious music file to cause a Samsung Galaxy S5's accelerometer to spell out the word "WALNUT" in a graph of its readings.

Sound waves can be employed to hack into the critical sensors used in a broad array of technologies including smartphones, automobiles, medical devices, and the Internet of Things.

All accelerometers have an analog core – a mass suspended on springs. When the object the accelerometer is embedded in changes speed or direction, the mass moves accordingly. The digital components in the accelerometer process the signal and ferry it to other circuits.

The researchers exploited the same phenomenon as that behind the legend of the opera singer breaking a wine glass. Key to the process is hitting the right note – the glass's resonant frequency. The researchers identified the resonant frequencies of 20 different accelerometers from five different manufacturers. Then instead of shattering the chips, they tricked them into decoding sounds as false sensor readings that they then delivered to the microprocessor.

The researchers noticed additional vulnerabilities in these systems as the analog signal was digitally processed. Digital low pass filters that screen out the highest frequencies, as well as amplifiers, haven't been designed with security in mind and in some cases inadvertently cleaned up the sound signal in a way that made it easier for the team to control the system.

The researchers have recommended ways to adjust hardware design to eliminate the problems. They also developed two low-cost software defenses that could minimize the vulnerabilities, and they've alerted manufacturers to these issues.

The University is pursuing patent protection for the intellectual property and is seeking commercialization partners to help bring the technology to market. The researchers presented a paper on the work on April 26, 2017 in Paris at the IEEE European Symposium on Security and Privacy. The paper is titled "WALNUT: Waging Doubt on the Integrity of MEMS Accelerometers with Acoustic Injection Attacks." The research was supported by the National Science Foundation.

Deterring In-Vehicle Network Attacks by Fingerprinting Electronic Control Units

Automotive network architectures were not traditionally designed with security in mind, and as manufacturers add software modules and external interfaces to vehicles, new attacks and vulnerabilities have emerged. Researchers have demonstrated how to compromise in-vehicle Electronic Control Units (ECUs), allowing an attacker to control vehicle maneuvers. To counter these vulnerabilities, Kang G. Shin, Kevin and Nancy O'Connor Professor of Computer Science, and CSE graduate student Kyong-Tak Cho have proposed an anomaly-based intrusion detection system, called Clock-based IDS (CIDS). CIDS measures the intervals of periodic in-vehicle messages in order to fingerprint ECUs and then monitors against this baseline.

Unlike state-of-the-art IDs, if an attack is detected, CIDS fingerprinting of ECUs also facilitates a root cause analysis; identifying which ECU mounted the attack. Based on the researchers' experiments on real vehicles, CIDS is shown to be capable of detecting various types of in-vehicle network intrusions.

Protecting Privacy of Bluetooth Low Energy Device Users

Bluetooth Low Energy (BLE) has emerged as an attractive technology for enabling Internet of Things (IoT) devices to automatically interact with other devices in their vicinity. However, Prof. Kang Shin and CSE graduate student Kassem Fawaz have studied the behavior of more than 200 types of BLE-equipped devices and discovered that the BLE protocol, despite its privacy provisions, fails to address the most basic threat of all—hiding the device's presence from curious adversaries.

The researchers proposed a new device-agnostic system, called BLE-Guardian, that protects the privacy of the users/environments equipped with BLE devices. It enables the users and administrators to control those who discover, scan, and connect to their devices. Their evaluation with real devices shows that BLE-Guardian effectively protects the users' privacy while incurring little overhead on the communicating BLE-devices.

The researchers presented their work at the 2016 USENIX Security Symposium.

Protecting Data With FlowFence

Emerging IoT programming frameworks, like smart homes and wearables, only support permission-based access control on sensitive data, making it possible for malicious apps to abuse permissions and leak data. To protect sensitive data, Prof. Atul Prakash and CSE graduate students Earlence Fernandes, Justin Paupore, and Amir Rahmati have created FlowFence.

FlowFence is a system that requires consumers of sensitive data to declare their intended data flow patterns, which it enforces with low overhead, while blocking all other undeclared flows. It achieves this by explicitly embedding data flows and the related control flows within the app structure, which enables apps on emerging IoT frameworks to compute using sensitive data while preventing data abuse.

Developers can use FlowFence by splitting their apps into two components, which would require less than 140 additional lines of code. The software adds little overhead and it would be useful to apply this to developing IoT programming frameworks to reassure users that an app will not abuse its permissions.

The researchers presented their work at the 2016 USENIX Security Symposium.

{1949} LOGIC OF COMPUTERS GROUP

After joining Michigan's Philosophy Department in 1946, Arthur Burks established the Logic of Computers research group in 1949. The group pondered the behavior of nerve nets and even asked the question: "Is the human a very complicated automaton?" Burks served as a principal architect for the first programmable electronic digital computer, the ENIAC, during WWII.

UNIVERSITY OF MICHIGAN BICENTENNIAL

You've Got Vulnerability!

Once security researchers discover and verify a vulnerability, they then inform those affected so that they may take proactive measures to secure their systems at scale. However, the factors affecting a notification's effectiveness have not been deeply explored.

A team of computer science researchers, including CSE graduate students Zakir Durumeric and Jakub Czyz, conducted an extensive study of methods for notifying thousands of parties that security issues are present within their networks with the aim of determining which types of notifications have the greatest impact.

The researchers monitored vulnerable systems for several weeks to determine their rate of remediation. By comparing with experimental controls, they analyzed the impact of a number of variables: choice of party to contact, message verbosity, the hosting of an informational website linked to the message, and translating the message into the notified party's local language. They also assessed the outcome of the emailing process itself (bounces, automated replies, human replies, silence) and characterized the sentiments and perspectives expressed in both the human replies and an optional anonymous survey that accompanied their notifications.

After notifying thousands of network operators of security issues present within their networks, the researchers found that notifications can have a significant positive effect on patching, with the best messaging regimen being directly notifying contacts with detailed information in the message itself.

The researchers presented their work at the 2016 USENIX Security Symposium.

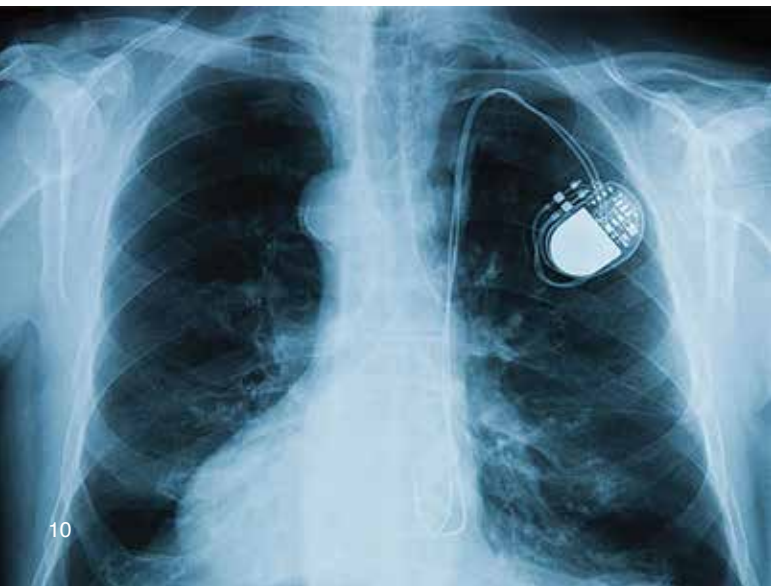
Once a security vulnerability has been found, what's the best way to let those affected know?

Holes Found in Report on St. Jude Medical Device Security

In August 2016, a controversial report claimed that pacemakers and other implantable heart devices made by the manufacturer St. Jude Medical contained security flaws that would leave patients vulnerable to hacking.

The investment firm Muddy Waters issued the report based on an investigation by cybersecurity research company MedSec Holdings. The two firms had a financial incentive in releasing the report: Muddy Waters had shorted St. Jude stock, betting that it would decline in value, and MedSec had arranged to share any profits from the short sale. St. Jude's stock price did indeed decline dramatically.

Prof. Kevin Fu, an expert in medical device security, questioned the accuracy of that report after reviewing MedSec's findings. Fu's team reproduced the error messages the report cited as evidence of a successful "crash attack" into a home-monitored implantable cardiac defibrillator. But they showed that the messages were actually the same set of errors you'd get if you didn't have the device properly plugged in.

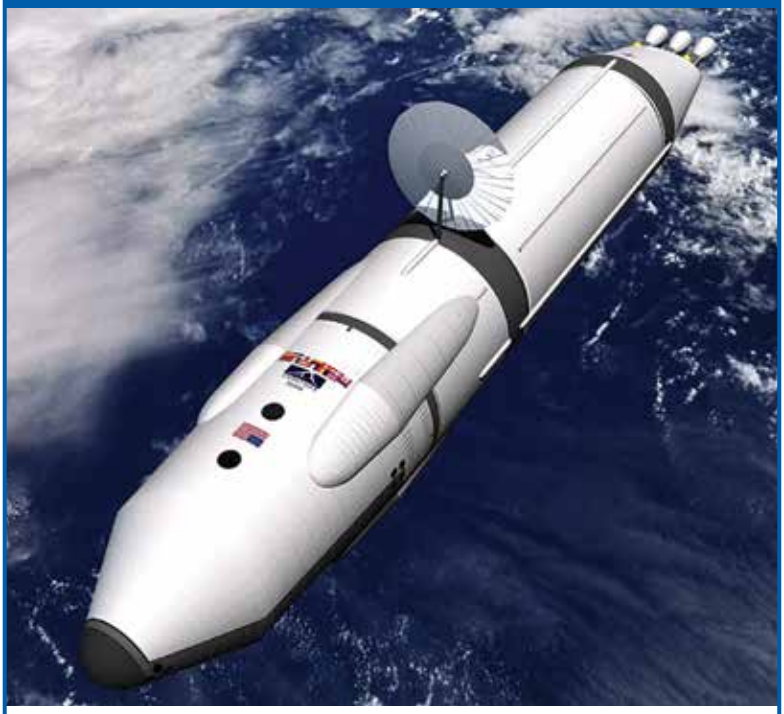


When it's implanted, a defibrillator's electrodes are connected to heart tissue via wires that are woven through blood vessels. Through these wires, implantable defibrillators can perform sensing operations and also send shocks if necessary. "When these wires are disconnected, the device generates a series of error messages: two indicate high impedance, and a third indicates that the pacemaker is interfering with itself," said Denis Foo Kune, former U-M postdoctoral researcher working with Prof. Fu.

The Muddy Waters report contains a screenshot that cites these very error messages as proof of a security breach. "But really, we believe the pacemaker is acting correctly," Fu said.

St. Jude has filed suit against Muddy Waters and MedSec Holdings and the matter is currently in the courts.

Creating a Computing Processor for NASA



Chiplet will provide significantly improved processing performance for future NASA missions.

Prof. Ron Dreslinski and Trevor Mudge, Bredt Family Professor of Engineering, will collaborate with the Boeing Company to enable a NASA project to create a high-performance spaceflight computing processor called Chiplet.

The Boeing and Michigan researchers will develop a prototype, the system software, a behavioral model, and evaluation boards for use in test and characterization.

Each Chiplet processor will contain eight general-purpose processing cores in a dual quad-core configuration, along with interfaces to memory and peripheral devices, and will have the flexibility to tailor performance, power consumption, and fault tolerance to meet widely varying mission needs.

The system software infrastructure for the computer processor will support both real-time operating systems and Unix/Linux based parallel processing. This infrastructure will also support hierarchical fault tolerance, ranging from single Chiplet deep space robotic missions to multi-Chiplet highly redundant human spaceflight missions.

The goal of Chiplet is to provide game-changing improvements in computing performance, power efficiency, and flexibility, which will significantly improve the onboard processing capabilities of future NASA and U.S. Air Force space missions.

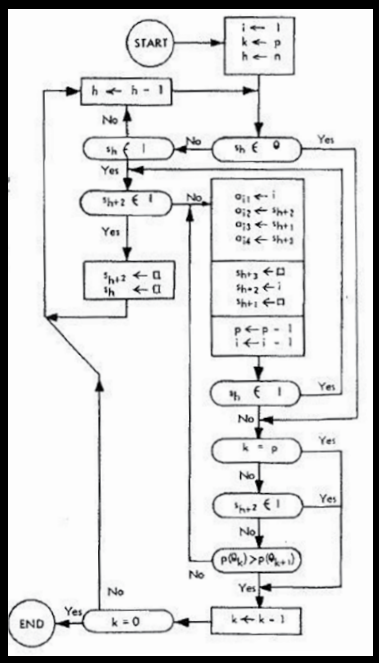
Creating Efficient Data-Centric Computing Systems

It is predicted that by the year 2020, data production from individuals and corporations is expected to grow to 73.5 zetabytes, a 4.4x increase from the year 2015. This will require a large amount of time and energy in moving data from storage to compute units. Prof. Reetuparna Das aims to design specialized data-centric computing systems that dramatically reduce these overheads.

The central vision of her research is to create in-situ compute memories, which re-purpose the elements used in these storage structures and transform them into active computational units. In-situ compute memories enable computation in-place within each memory array, without transferring the data in or out of it. Such a transformation could unlock massive data-parallel compute capabilities and reduce energy spent in data movement through various levels of memory hierarchy, thereby directly addressing the needs of data-centric applications.

{1957} GENERALIZED ALGEBRAIC TRANSLATOR

In 1957, Bruce W. Arden and Robert Graham began development of the Generalized Algebraic Translator (GAT), a compiler for the IBM 650 that simplified programming. The two published a paper on this work in 1959.



UNIVERSITY OF MICHIGAN BICENTENNIAL

NEXT GENERATION COMPUTING + ELECTRONICS

Prof. Wei Lu and the new memristor computer circuit prototype

Next-Gen Computing Inspired by Biology

Inspired by how mammals see, a new "memristor" computer circuit prototype developed by Prof. Wei Lu and his group has the potential to process complex data, such as images and video, orders of magnitude faster and with much less power than today's most advanced systems.

Faster image processing could have big implications for autonomous systems such as self-driving cars.

Lu's next-generation computer components use pattern recognition to shortcut the energy-intensive process conventional systems use to dissect images. In this new work, he and his colleagues demonstrate an algorithm that relies on a technique called "sparse coding" to coax their 32-by-32 array of memristors to efficiently analyze and recreate several photos.

This approach, says the researchers, is an important milestone in the development of large-scale, low-power neuromorphic computing systems.

Memristors are electrical resistors with memory—advanced electronic devices that regulate current based on the history of the voltages applied to them.

They can store and process data simultaneously, which makes them a lot more efficient than traditional systems.

"The tasks we ask of today's computers have grown in complexity," Lu said. "In this 'big data' era, computers require costly, constant and slow communications between their processor and memory to retrieve large amounts of data."

But like neural networks in a biological brain, networks of memristors can perform many operations at the same time, without having to move data around. As a result, they could enable new platforms that process a vast number of signals in parallel and are capable of advanced machine learning.

"We need our next-generation electronics to be able to quickly process complex data in a dynamic environment. You can't just write a program to do that. Sometimes you don't even have a pre-defined task," Lu said.

If their system can be scaled up, they expect to be able to process and analyze video in real time in a compact system that can be directly integrated with sensors or cameras.

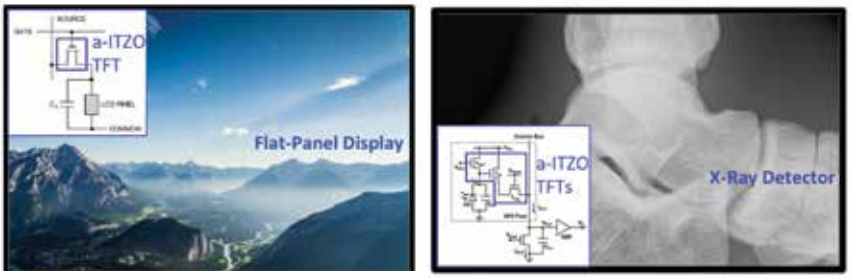
The research was published in *Nature Nanotechnology* in the article, "Sparse Coding With Memristor Networks," authored by Patrick Sheridan, Fuxi Cai, Chao Du, Wen Ma, and Profs. Zhengya Zhang and Wei Lu.

The work is part of a $6.9 million DARPA project called "Sparse Adaptive Local Learning for Sensing and Analytics" that aims to build a computer chip based on self-organizing, adaptive neural networks.

Ushering in the Next Generation of Flat-Panel Displays and Medical Imagers

Research that is expected to directly impact the future of the flat-panel display and imager industries has been selected as an Editor's Choice by the *Journal of Solid-State Electronics*.

In addition, the paper highlighted by *Advances in Engineering* due to its exceptional scientific importance.



Next generation high resolution flat-panel devices

The article, *DC sputtered amorphous In–Sn–Zn–O thin-film transistors: Electrical properties and stability*, co-authored by Prof. Jerzy Kanicki, ECE graduate student Chumin Zhao, and Dr. Mitsuru Nakata (NHK Science and Technology Research Laboratory, Japan), describes a new technology that may help usher in the next generation of flat-panel displays and imagers.

Today's flat-panel displays (FPDs) and flat-panel imagers (FPIs) based on thin-film electronic devices are widely used in our daily lives, such as flat-panel televisions and a wide variety of medical imagers.

However, the bulk of these FPDs and FPIs are based on technology that is more than 30 years old. While several approaches have been tried to improve the technology, there are limitations that prevent them from being manufactured using a large area fabrication process with our existing manufacturing infrastructure.

With the field wide open for just such an improvement, Prof. Jerzy Kanicki and his team developed a new technology using amorphous In–Sn–Zn–O thin-film transistors (a-ITZO TFTs). This technology combines the advantages of current amorphous silicon (a-Si:H) TFT technology, which allows for large area mass production but is not suitable for next-generation devices, as well as low-temperature polysilicon TFT technology, which works well for organic light-emitting devices used for small area FPDs, but is not suitable for mass production.

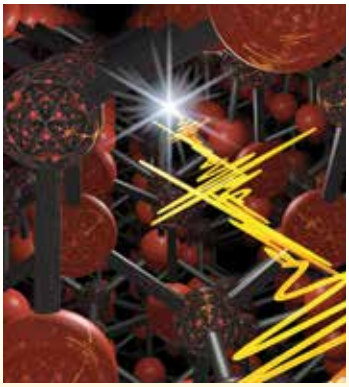
"We expect breakthroughs in both the flat-panel display and imager industries using this new technology in the near future," said Kanicki.

'Lightwave' Computers

Extremely short, configurable "femtosecond" pulses of light demonstrated by an international team that includes new faculty member Mack Kira could lead to future computers that run up to 100,000 times faster than today's electronics.

The method moves electrons faster and more efficiently than electrical currents—and with reliable effects on their quantum states. It is a step toward so-called "lightwave electronics" and, in the more distant future, quantum computing, said Kira.

Electrons moving through a semiconductor in a computer occasionally run into other electrons, releasing energy in the form of heat. But, a concept called lightwave electronics proposes that electrons could be guided by ultrafast laser pulses. While high speed in a car makes it more likely that a driver will crash into something, high speed for an electron can make the travel time so short that it is statistically unlikely to hit anything.



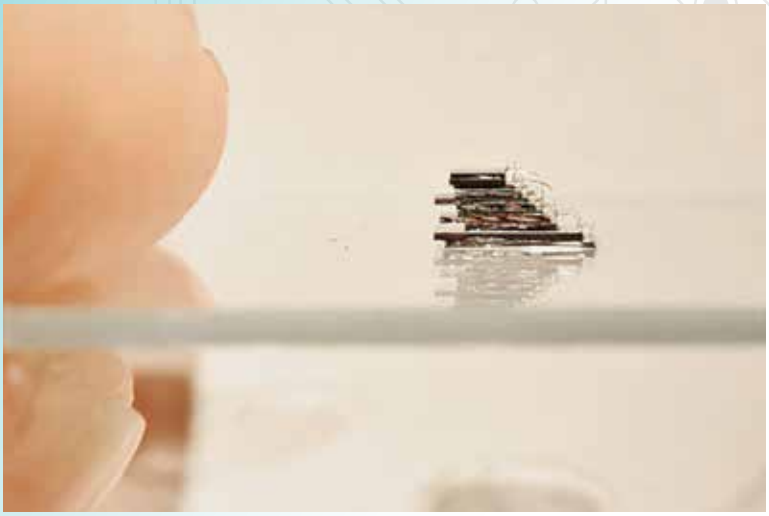
A semiconductor crystal has shown an unprecedented capacity to shape ultrashort laser pulses.
Image credit: Fabian Langer, Regensburg University

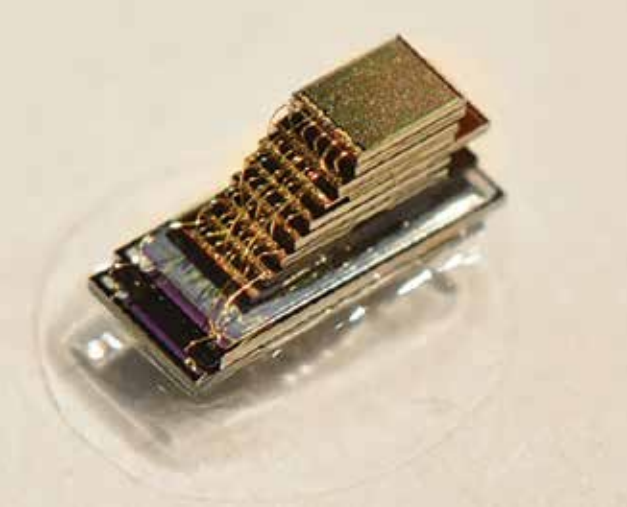
"In the past few years, we and other groups have found that the oscillating electric field of ultrashort laser pulses can actually move electrons back and forth in solids," said Rupert Huber, professor of physics at the University of Regensburg who led the experiment. "Everybody was immediately excited because one may be able to exploit this principle to build future computers that work at unprecedented clock rates—10 to a hundred thousand times faster than state-of-the-art electronics."

But first, researchers need to be able to control electrons in a semiconductor. This work takes a step toward this capability by mobilizing groups of electrons inside a semiconductor crystal using terahertz radiation.

"We managed to launch one electron simultaneously via two excitation pathways, which is not classically possible. That is the quantum world. In the quantum world, weird things happen," Kira said.

Intelligent Chips for a Smart, Happy, and Healthy World





Continuing their leadership in the field of solid-state circuits and systems-on-a-chip, Profs. David Blaauw and Dennis Sylvester presented a total of 10 papers at the 2017 IEEE International Solid-State Circuits Conference (ISSCC). This year's theme was Intelligent Chips for a Smart World.

In addition, Prof. Sylvester presented a Short Course on Ultra-Low Power References and Oscillators and chaired or co-chaired two sessions; and Prof. Michael Flynn spoke about hybrid data converters in the Forum, Pushing the Performance Limit in Data Converters.

Most of the papers were in some way related to their Michigan Micro Mote (M^3) computers, the first standalone millimeter-scale computing systems in the world.

The papers described:

A processor for **autonomous navigation** that is the first to render realistic automobile scenes with industrial standard performance.

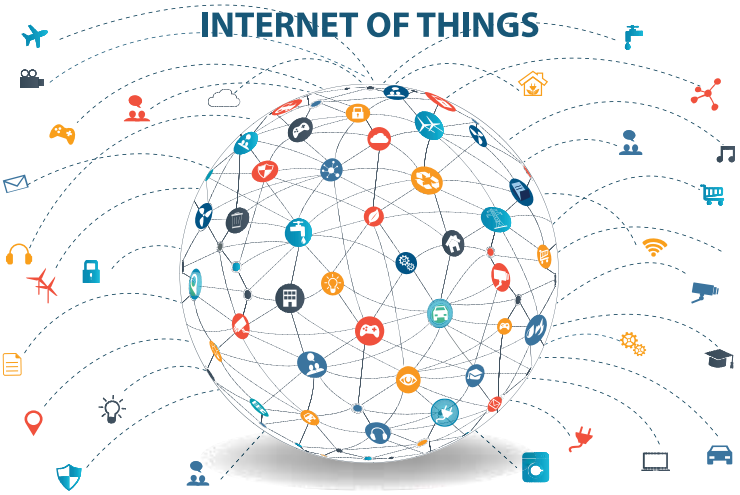
A millimeter-scale wireless **sensor node** that is capable of 20m of **wireless communication**, even in obstructed areas.

A physically unclonable function (PUF) designed for **IoT applications** that make the wireless sensor nodes **more secure**.

A **fully integrated temperature sensor** for use in **IoT devices to monitor environmental or system/chip conditions**. The novel digital implementation makes the design very portable and highly scalable to new CMOS processes.

Adaptation of their miniature sensor nodes for **environmental monitoring** under **high temperature** conditions, such as **oil exploration**. Enabling low-power **deep learning** in mobile IoT applications to provide **intelligent on-chip processing** prior to information being sent to the cloud.

Development of a **long-term acoustic sensing system** with the ability to accurately label specific sounds that requires less than **20nW power** consumption, which is more than 2 orders of magnitude lower than state-of-the-art acoustic sensing systems. Such sensing devices can be used for agricultural monitoring to detect pests or precipitation, infrastructure health tracking, and security/safety monitoring to identify dangerous conditions.



Additional papers impacting personal health described:

A **wearable sensor** capable of detecting the exposure of an individual's skin to **light radiation**. Reduced light exposure exacerbates **depression**, while high levels of sunlight exposure are well known as the primary cause of **skin cancer**.

A method for **powering** ultra-small wireless systems such as **implantable biomedical devices**.

In addition, Profs. Zhaohui Zhang and Marios Papaefthymiou (now Dean at UC-Irvine) co-authored a paper describing research to **improve** noise interference in **hearing aids** while preserving interaural time difference, which is important to allow the individual to distinguish where the sound is coming from.

While most of the work was accomplished by Michigan faculty, students, and alumni, they have also partnered with Taiwan Semiconductor Manufacturing Company, InvenSense, Inc., Seoul National University, Texas A&M University, and their own startup company, Cubeworks.

Winning Design for Brain Signal Detection

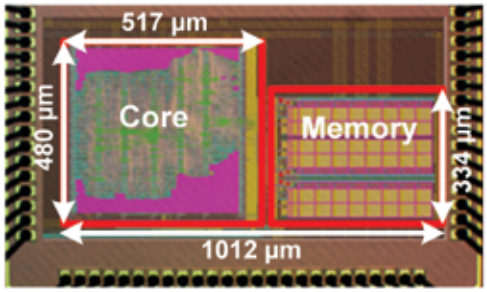
Prof. Dennis Sylvester and colleagues in Singapore and Korea developed a power and area efficient processor for real-time neural spike-sorting.

Spike sorting is a means of detecting spikes in brain signals and assigning them to an individual neuron source. It is the first step to be taken when decoding brain signals, such as those taken during multi-electrode intracranial recording, used in applications such as neural prosthetics and neuroscience research.

Traditionally, neural signals from a recording chip are transmitted to a nearby computer for sorting. However, on-chip spike sorters exhibit much better power efficiency with shorter lag time, which is essential for real-time multi-channel neural signal processing.

The final fabricated chip was 10x smaller than its nearest competitor, and is the first known real-time multi-channel spike-sorting chip to include a spike detector, feature extractor, dimensionality reduction, and clustering all on the same chip.

The research was selected as a design contest winner at the 2016 IEEE/ACM International Symposium on Low-Power Electronics and Design (ISLPED). The paper, "A 128-Channel Spike Sorting Processor Featuring 0.175 W and 0.0033 mm^2 per Channel in 65-nm CMOS," was co-authored by Seyed Mohammad Ali Zeinolabedin (Nanyang Technological University, Singapore), Anh Tuan Do (Institute of Microelectronics, Singapore), Dongsuk Jeon (Seoul National University, Korea), Dennis Sylvester, and Tony Tae-Hyoung Kim (Nanyang Tech).

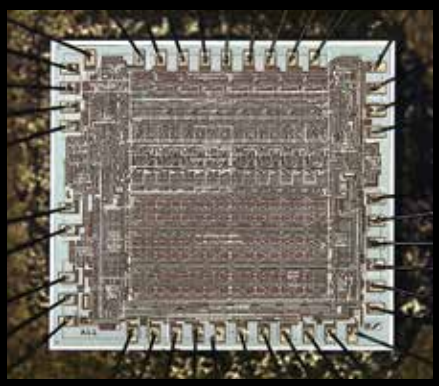


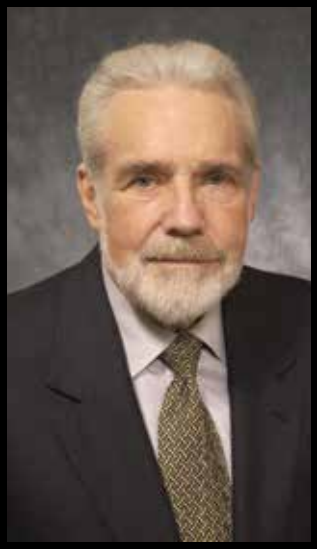
Technology	: 65 nm CMOS
Supply voltage	: 0.54 V
Total power	: 22.4 µW
Leakage power	: 3.8 µW
Operating freq.	: 3.2 MHz
Average accuracy	: 72% ~ 87%
Number of Ch.	: 128
Data reduction	: 257
Total area	: 0.414 mm^2

128-channel spike sorting chip micrograph for intracranial recording

{1969} FIRST SINGLE-CHIP CPU MICROPROCESSOR

Lee Boysel (BSE MSE EE 1962 1963) founded the company Four-Phase Systems, Inc. in 1969 to commercialize a microprocessor chip called the AL1, now considered the first integrated circuit with more than 100 logic gates. It was used in computers built by Four-Phase, but never patented. The AL1 preceded similar chip designs by Intel and Texas Instruments, which came out with their commercial microprocessors in the early 1970s. Four-Phase Systems was sold to Motorola, Inc. in 1982 for a reported $253M stock deal.





The Future of Touchscreens May Be Transparent Silver

The thinnest, smoothest layer of silver that can survive air exposure has been laid down in Prof. Jay Guo's lab, and it could change the way future touchscreens and displays are made.

Current screens are typically made of indium tin oxide, available primarily from Canada and China. The material has been fairly inexpensive, but demand for touch screens has already driven up the price, a trend that is expected to continue.

Silver has been seen as a suitable alternative for several years, but there's been a problem adapting it for this purpose. It's been impossible to make a continuous layer of silver less than 15 nanometers thick, or roughly 100 silver atoms. This is because silver has a tendency to cluster together in small islands rather than extend into an even coating.

Now Guo's team has been able to overcome inherent fundamental material limits by combining silver with a little bit of aluminum, about 6%. They were able to produce exceptionally thin (seven nanometers), smooth layers of silver that are resistant to tarnishing. And by applying an anti-reflective coating, they made one thin metal layer up to 92.4 percent transparent.

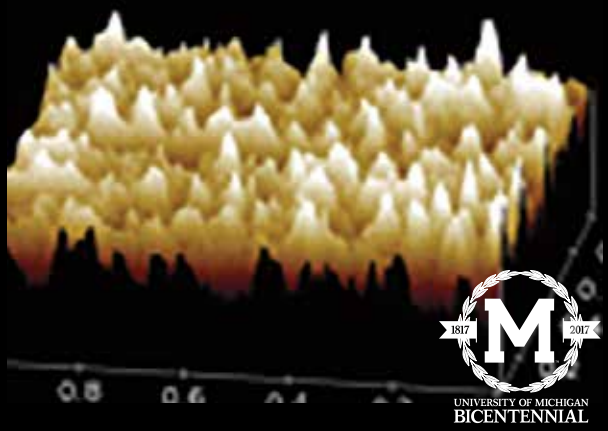
In addition to their potential to serve as transparent conductors for touch screens, the thin silver films offer two more tricks, both having to do with silver's unparalleled ability to transport visible and infrared light waves along its surface.

The use of thin silver films inside computers can improve computing power by affecting both the transfer of information within a silicon chip and the patterning of the chip itself through metamaterial superlenses. These superlenses can image objects that are smaller than the wavelength of light, which would blur in an optical microscope. It can also enable laser patterning—such as is used to etch transistors into silicon chips today—to achieve smaller features.

Guo and former student and alumnus Cheng Zhang have applied for a patent and are seeking partners to bring the technology to market.

{1988} QUANTUM DOTS

The discovery in 1988 by Pallab Bhattacharya with Jasprit Singh of self-organized quantum dots at Michigan was 7-10 years ahead of the research community. In the coming decades, Bhattacharya, Singh, Jamie Phillips, and Ted Norris were among the first to develop a room-temperature quantum dot laser in 1996, a milestone in semiconductor lasers. In recent years, Bhattacharya's advancements in quantum dot lasers are expected to lead to improved solid-state lighting, optical data storage, medical devices, and more.



Solving Problems With Data

“Learning Database” Finds Answers 200X Faster

The world is drowning in data. The digital world is up to well over one billion gigabytes, and new data is streaming in far more quickly than our ability to process it. As a result, the databases that handle the world’s largest troves of data can take minutes or hours to spit out an answer when a researcher or employee submits a question. That’s a problem, because data-driven analytics is increasingly being used for driving scientific research and making complex business decisions. Studies have shown that even a short delay can hamper the productivity of a human user and stifle his/her innovation. In addition, churning data centers all over the world constitute a significant and growing share of the world’s electricity usage.

Prof. Barzan Mozafari

But a team of University of Michigan researchers, including CSE Prof. Barzan Mozafari, may have a solution—a piece of software that makes databases work smarter, not harder. The team that created the software, which is called Verdict, says that it can make databases deliver answers more than 200 times faster, using 200 times less computing power and electricity while maintaining 99% accuracy.

Verdict is the first working example in a new field of research called “database learning.” Similar to machine learning, database learning aims to build systems that learn from each query that users submit. Verdict gets smarter with every new query, enabling the database to return accurate answers without having to trawl through a massive trove of data every time.

Instead of an entirely new database, the tool is what’s known as a “thin layer”—a small, nimble piece of software that can be placed in front of any existing database system, improving performance while leaving the core system unchanged. Verdict speeds up performance by leveraging advanced statistics on modeling the underlying distribution of the data, which eventually eliminates the need to look at the data itself.

“Databases have been following the same paradigm for the past 40 years—you submit a query, it does some work and provides an answer. When a new query comes in, it starts over. All the work from previous queries is wasted,” said Mozafari.

The new technology could enable databases to provide answers in seconds instead of hours, boosting productivity and using a fraction of the computing power and electricity of conventional databases.

When the software is first placed in front of a database, it simply stores away queries that go in and out of the database, compiling them into a compact structure called a query synopsis. Once Verdict goes into action, it breaks each query up into smaller components called snippets and uses them to build a mathematical model of questions and answers. When new queries come in, it uses that model to point the database to a certain subset of data where the answer is most likely to lie.

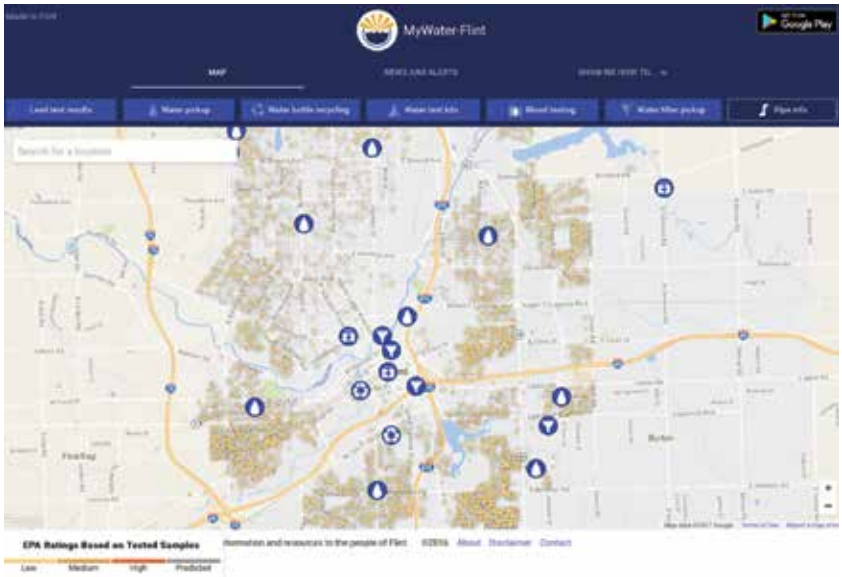
Verdict itself uses minimal computing resources, and a recent paper presented by Mozafari and his students showed that Verdict never slows performance. It also enables users to tailor the balance between speed and accuracy to fit individual applications.

Verdict represents a preliminary proof of concept; Mozafari believes a commercial product is likely to follow soon. In his view, the core technology will evolve into a variety of new use-cases as it finds new applications in the industry.

“We’ve really just scratched the surface of what database learning can do—the important thing is that we’ve turned the mechanics of the database upside down,” he said.

The project is detailed in a paper titled “Database learning: Toward a database that becomes smarter every time.” The paper was presented at the 2017 ACM SIGMOD conference.

Google-Funded Flint Water App Helps Residents Find Lead Risk, Resources



In 2016, a partnership between Google.org, U-M Ann Arbor's Michigan Data Science Team, and a student team at U-M Flint led to the development of a prototype smartphone app for use by Flint residents to identify and predict points of lead water contamination.

Since then, the researchers have launched a mobile app and website, called Mywater-Flint, to help the community and government agencies manage the ongoing water crisis. Through it, residents and city employees can:

- Access a city-wide map of where lead has been found in drinking water
- Discover where service line workers have replaced infrastructure that connects homes to the water main, and where they're currently working
- Locate the nearest distribution centers for water and water filters
- Find step-by-step instructions for water testing
- Determine the likelihood that the water in a home or another location is contaminated, among other features.

Google.org provided a $150,000 grant to fund the project. Google engineers, UX designers, and strategists also volunteered to help support the university and its students with the development of the app by providing consulting advice on their areas of expertise, such as conducting user research and data visualization.

To create the app and the website, the researchers collaborated with the City of Flint and the Michigan Department of Environmental Quality to acquire water contamination samples and joined that data with existing public data. They used the data to build a predictive model to predict which homes are more likely at risk of high lead contamination.

While all homes have some level of risk, the app can predict which ones are more likely based on factors such as the age of the property, its location, value, and size. Beyond that, it pulls together publicly available data from many state agencies, nonprofits, and other institutions.

"Our website and app makes it much easier for a resident to view the water test results for their home, business, church, etc. Hopefully, it will inspire those who haven't tested their home to do so," said Miyako Jones, who received her bachelor's and master's degrees in computer science from U-M Flint.

Their research is currently helping Flint city officials start the process of replacing lead pipes in homes. In March 2017, the State of Michigan agreed to allot $87 million to replace thousands of lead pipes throughout Flint over the next three years.

{1967} THE MICHIGAN TERMINAL SYSTEM

The Michigan Terminal System (MTS) – which replaced the use of batch mode, punchcard-driven computing with a multiprogramming, multiprocessing, terminal-based system – transformed the user experience at Michigan, giving each user the impression that there were no other users. MTS remained in use until 1997.

Shadows in the Dark Web

Prof. Michael Cafarella

Search engines like Google, Yahoo!, and Bing catalog only about five percent of what exists online, and this small portion—the surface web—is where almost everyone stays. The rest of the Internet is known as the deep web. Search services don't index the deep web because temporary websites pop in and out, and the content just doesn't follow the same rules.

Deeper than the deep web is the dark web, which can only be navigated with special browsers and tools. Sites in the dark web—Silk Road is the best-known example—offer all kinds of illicit material: pirated media, drugs, weapons, pornography, prostitution, and more. It's a safe spot for criminals to lurk, but recent research has made hiding harder.

Working with DARPA (the Department of Defense's Advanced Research Projects Agency), Prof. Michael Cafarella is bringing light to the dark web with a project called Memex. Memex uses search functions that sidestep the limitations of the text-based search engines that most of us use, making the dark web scrutable. Since 2014, Memex has focused on human trafficking, not only because it's a particularly grim industry, but also because money from the sex trade often funds other illegal activities, such as drugs and weapons.

"We're trying to build data tools for addressing crime—in particular human trafficking—where the Internet might provide a lot of data," says Cafarella. He's analyzed something like 80 million sex ads so far, using machine learning and image recognition to uncover who's behind those shady business deals.

Web Crawling for Clues

The hard part of this work is information extraction. Ads for sex workers in the dark web contain price, location, and service details. Earlier technology, Cafarella says, suffered from mistakes and imprecision and missed important data, too. "Just as if a reader were being really fast and sloppy, they might skip over a lot of things," he says.

His program also scans ads for phone numbers—even those numbers that human traffickers write by hand or otherwise obscure to dodge automated searches. "They'll put in an image instead of text, like you would your email address if you want to avoid spammers," Cafarella says. "Or they'll spell it in a crazy way, or use a mixture of words and numbers to spell it out."

Dark Web Discount

Computer code and web crawlers can't, of course, perfectly translate the human reality captured in sex ad data. Here's where social science comes in.

"The goal is to understand economic models of how people do the pricing," says Cafarella. "If we can understand the market and how and why people price, then we can look at a sex worker who's much cheaper in her advertisement than you might expect, which suggests that the worker is not pricing her own services." He says law enforcement can flag and prioritize such outliers who don't follow expected economic incentives. Those sex workers may create a trail toward a human trafficker who's actually making the rules and setting the price.

Although Memex research currently revolves around the sex trade, Cafarella's innovations can help solve other problems in science, industry, and government.

"I would never have thought a few years ago that database and data-mining research could have such an impact, and it's really exciting," says Cafarella. "Our data has been shipped to law enforcement, and we hear that it's been used to make real arrests. That feels great."

Secrets lurk in the dark web, the 95 percent of the Internet that most of us can't see. Prof. Michael Cafarella is bringing some of those secrets to light, making the digital and the real world a little safer.

Autonomy in Robots, Transportation, and More

Robotic Emergency Response

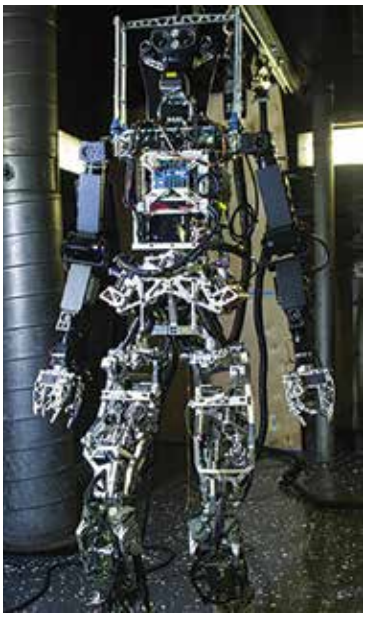
Walking over unstable ground, dealing with tangles in string, rope or wire – these tasks aren't easy for humans. For today's robots, they're impossible.

But if the Navy is going to have an autonomous maintenance and emergency-response crew, the 'bots will have to learn. The Office of Naval Research has awarded Prof. Dmitry Berenson $1.1 million to help make this happen.

One of the new abilities that Berenson and his group will help robots attain is navigating unfamiliar environments by reusing previous experience from similar environments. When the robot sees debris-covered stairs, for example, it might skip straight to the plan that worked last time it saw stairs, then adapt to the new details. The key, Berenson says, will be in teaching robots to better adapt to unknowns.

On a swaying ship, even the floor beneath a robot's feet is in motion. That's why Berenson's group is focusing on how robots can use their hands to handle unexpected forces, by bracing against walls or using other objects as support.

Berenson is working closely with a team at Virginia Tech, which built and operates the SAFFiR humanoid robot. SAFFiR is designed to help fight fires on ships, but to be truly useful in an emergency, the robot needs to be able to handle tight corridors and steep slopes that don't look and feel like they normally do – perhaps the floor is warped from heat or covered in debris from an explosion.



To adapt to this unique environment, Berenson and his students are designing algorithms that build rough maps of the floor and walls with SAFFiR's laser scanner and make quick decisions about foot and hand placements.

They also intend to help robots handle soft objects, even objects that can change shape.

1st in Line for Cassie Blue: New Bird-Inspired Walking Robot

A new two-legged robot called Cassie Blue has recently arrived at Prof. Jessy Grizzle's lab. It's the third generation biped that's been part of the Grizzle team, and is part of a legacy of 'bots that have been able to walk unassisted (and without the help of vision sensors) over rough terrain and jog a nine-minute mile with greater elegance than seen before.

Cassie Blue comes from the Cassie line of robots from Agility Robotics, spun out of the lab of Oregon State University's Jonathan Hurst, who is a longtime collaborator of Grizzle's. It is loosely modeled on the cassowary, a flightless bird similar to an ostrich. Legs with backward-facing knees attach to a short torso that holds batteries, motors and a pair of computers. U-M is receiving the first unit.

"Cassie Blue is tough. It is designed for the rough-and-tumble life of an experimental robot. In principle, we should not have to use a safety gantry of any kind," said Grizzle, the Elmer G. Gilbert Distinguished University Professor and Jerry W. and Carol L. Levin Professor of Engineering. "This will allow us to take the robot in wild places."

Another big change in Cassie Blue will be its ability to "see." Like MARLO and MABEL, Grizzle's previous bots, Cassie Blue will still be able to "feel" its way along – important for future rescue robots in smoky buildings, for example – but perception will help the new robot handle more extreme terrain.

Cassie Blue won't be the first biped in Prof. Grizzle's lab to walk like a bird. MARLO and her cousin at the University of Oregon, ATRIUS, were modeled after an ostrich: as tall as a person, perched atop scrawny legs, and partially incorporating the mechanics of bird athletics.

Before MARLO there was MABEL. MABEL set the record for the fastest bipedal robot with knees, and MARLO took that work into the three-dimensional world with free-standing motion. Recently, MARLO mastered the ability to walk on steep inclines as well as random, uneven terrain, including portions of the Wave Field here on North Campus.

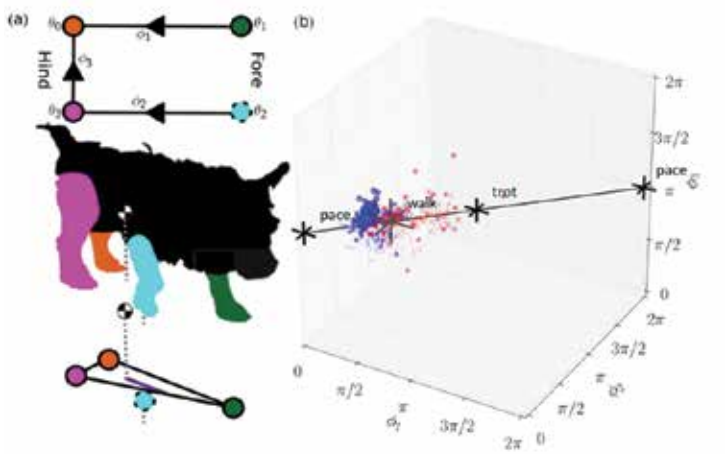
The remarkable agility accomplished by all these robots can be attributed to the elegant control algorithms fashioned by Grizzle and his team. Because Grizzle openly publishes his research, the same algorithms are being adapted to other bipedal robots in labs around the world.

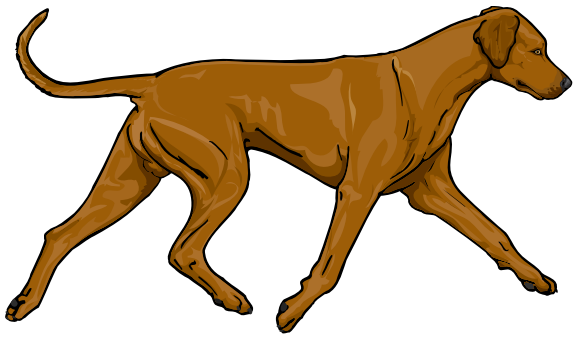
Building More Stable Quadruped Robots: A Dog's Point of View

Research into the gait of dogs may lead to improved design of quadruped robots and how we control their movement. Prof. Shai Revzen, a biologist turned roboticist, brings a unique perspective to the study of animals, one that's beginning to be heard by the biological community as well.

"The research is shaking up both disciplines," said Revzen, "giving biology a new tool to look at things, and giving robotics a sense of benefit from what we know in nature in a direct, simple way that's not just naively copying what you see."

In a collaboration with members of the Royal Veterinary College and other roboticists, Revzen sought to discover which of many gaits a dog would favor when encountering disturbances in the environment, such as bumpy turf.





What Revzen discovered in this research suggests that quadruped animals, like dogs, will attempt to move in a way that is longitudinally stable. This movement can be expressed mathematically. By applying the math to a quadruped robot, you might get a robot that can adapt more naturally to its surroundings. When speed is of the essence, such as in a search and rescue scenario, that extra time may become critical to a successful outcome.

Also – what if something happens to one of the four legs? Revzen believes by looking closely at what animals do and applying a mathematical model recovering the cyclic relationships between the legs, he'll be able to program a robot to recover much more quickly than what is currently possible with other methods.

His ultimate goal is to formulate a theory of robust locomotion that can capture what's happening in nature, in order to apply it to a field like robotics.

Shai Revzen Part of a New Five-Institution MURI Focused on the Control of Dynamic Systems

Shai Revzen is a member of a new five-institution team that will take advantage of recent advances in computation for the modeling and control of dynamic systems. The research is funded under a $6.25 million, five-year Multi-University Research Initiative (MURI) based at the University of California, Santa Barbara, and called "From Data-Driven Operator Theoretic Schemes to Prediction, Inference and Control of Systems (DDOTS to PICS)."

The Michigan team will focus on developing tools for linearization of hybrid systems both offline and on-the-fly, and application of these tools to the control of robots.

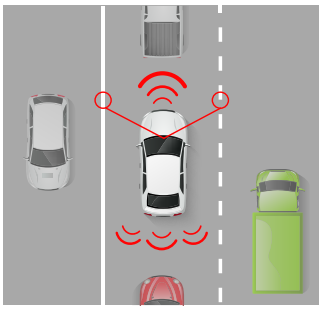
Cyber-Physical Systems: It's a Control Issue

Prof. Necmiye Ozay received a Nonlinear Analysis: Hybrid Systems Paper Prize for research that has implications for any autonomous system, including robots and autonomous vehicles.

The paper, "Finite Abstractions With Robustness Margins for Temporal Logic-Based Control Synthesis," was co-authored by Prof. Jun Liu (University of Waterloo).

The authors demonstrated that it is possible to synthesize provably-correct robust feedback controllers that can handle various types of imperfections in the models or measurements.

One example of an imperfection is an implementation imperfection. "For example," explained Ozay, "when an embedded controller computes a control decision, the computation time might vary from one step to another, a problem referred to as jitter. Most control design techniques ignore these variations and assume ideal uniform sampling. The new robust control synthesis algorithms can guarantee correct execution even in the existence of such variations."



A simple adaptive cruise control system was used by the authors to illustrate robustness–performance trade-offs. Ozay gives an example of how robustness-performance trade-offs can be used in such a system:

"Assume you want to decide between two sensors, one very high-precision (and very expensive) and one slightly less accurate (but cheaper). To work with the latter sensor, your controller needs to be more robust and its overall performance may decrease a bit as a result. Our algorithms can help designers to precisely know how much the performance of the overall system will degrade with a change in the sensor precision so that the designers can pick the best sensors for their needs."

The prize is awarded to the authors of two selected papers published in the journal *Nonlinear Analysis: Hybrid Systems* in the three years preceding the International Federation of Automatic Control (IFAC) World Congress.

COVE: A Tool for Advancing Progress in Computer Vision

Computer vision is integral to many forms of artificial intelligence, with applications ranging from the critical (autonomous vehicles recognizing pedestrians), to useful (finding a video to show you how to cook your next delicacy), to just fun (searching for images of a recent family vacation). Recent technical advances in computer vision have revealed that a sure pathway to continued progress in the field lies in easy access to a massive network of reliable and diverse open source datasets. Unfortunately, nothing like this currently exists.

To remedy the situation, a new project has been launched with the support of the National Science Foundation, the Computer Vision Foundation, and computer vision experts around the world. Based at the University of Michigan with collaborators at Boston University and the University of Notre Dame, the program aims to centralize available data in the intelligent systems community through a Computer Vision Exchange for Data, Annotations and Tools, called COVE.

Using the KITTI dataset, Prof. Corso and colleagues were able to create a 3D model for handling occlusions that can assist in road scene understanding by driverless cars.

The goal of COVE is to provide open and easy access to up-to-date, varied datasets, annotations, and their relevant tools. The project promises to have an immediate and far-reaching impact on the computer vision community as well as researchers involved in machine learning, multimedia, natural language processing, data mining, and information retrieval.

"COVE will allow a large component of the information and intelligent systems community to build on the work of others in ways not currently possible," said project director, Prof. Jason Corso.

"If a self-driving car learns to detect objects from a dataset collected in California," said Prof. Kate Saenko, "it will be biased towards sunny weather conditions and may fail to see objects in rain or snow. This project will help the community understand how such dataset biases can be addressed." Prof. Saenko is a co-PI on the project from the Computer Science Department at the University of Boston.

"Thanks to our unique partnership with the Computer Vision Foundation, COVE has excellent prospects to become the primary data resource for the entire field," said Prof. Walter Scheirer (University of Notre Dame), the third co-PI on the project.

Robotic Control in Cluttered Environments

Prof. Chad Jenkins is currently working on a project to improve the ability of robots to manipulate and interact with objects.

People can use their cognitive skills to name objects, provide an understanding of the geometrical structure of objects, and describe an object's behavior in relation to other objects. The project will develop a natural user interface that enables people to provide such information by drawing and sketching on top of the robot's view of the world. Physical simulation will then be used to fill in the missing gaps needed for a robot to complete autonomous manipulation tasks.

Prof. Chad Jenkins in his robotics lab.

The project aims to improve goal-directed dexterous robotic manipulation in cluttered and unstructured environments through sketching and physical simulation. Robots operating in human environments face considerable uncertainty in perception due to physical contact and occlusions between objects. This project will address such perceptual uncertainty by combining methods for probabilistic inference with natural sketch-based interfaces to extract, label, and automatically infer the geometry, pose, and behavior of objects in complicated scenes.

ImageNet Provides Researchers With an Easily Accessible Image Database

The explosion of image data on the Internet has the potential to foster more sophisticated and robust models and algorithms to index, retrieve, organize, and interact with images and multimedia data. Computer science researchers, including Prof. Jia Deng, have created ImageNet, a large-scale labeled image database that has powered many recent advances in computer vision.

ImageNet is organized according to the WordNet hierarchy, where each meaningful concept in WordNet, possibly described by multiple words or word phrases, is called a "synonym set" or "synset". In ImageNet, the researchers aim to provide on average 1000 images to illustrate each synset.

They hope that the scale, accuracy, diversity, and hierarchical structure of ImageNet can offer unparalleled opportunities to researchers in the computer vision community and beyond.

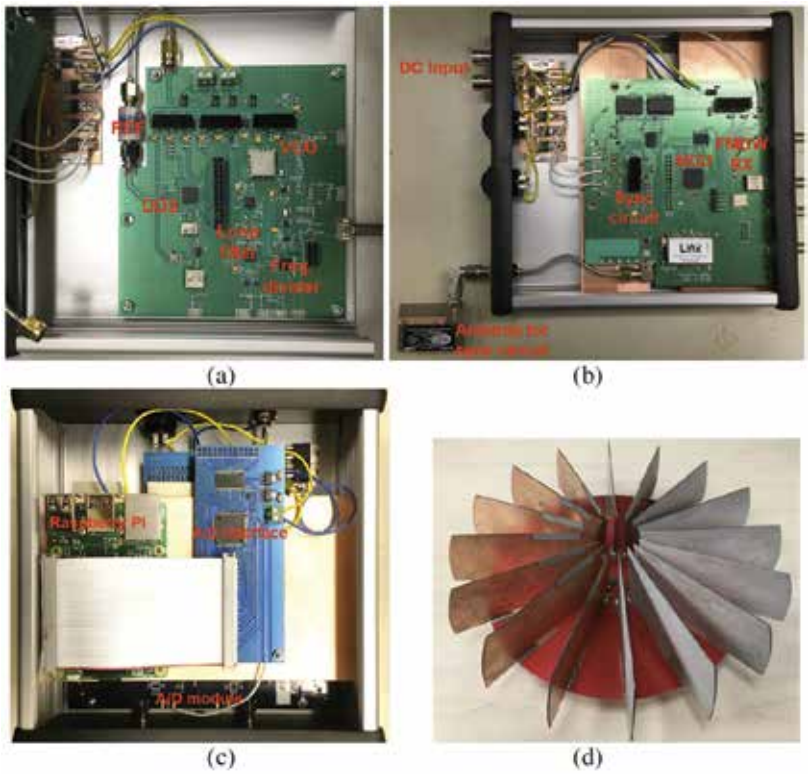
SEEING THROUGH WALLS

Through-the-wall imaging is a growing field that enables better threat assessment in rescue and law enforcement settings. A new system created by doctoral student Behzad Yektakhah with Prof. Kamal Sarabandi improves on the speed, portability, and accuracy of many commercial models.

While existing systems are time consuming to set up and require you to move the antenna to collect data in different directions, this new system uses an all-directional antenna that can operate remotely from the middle of a room.

The system can be accessed from outside the building, while gathering high-resolution data from an entire room at once. Yektakhah fabricated and tested a fully-functioning imaging radar system, and also created signal processing software to work on the collected data.

Yektakhah received an honorable mention for his paper, describing this research "All Directions Through the Wall Imaging Using Omnidirectional Bi-static FMCW Transceivers," co-authored by Prof. Kamal Sarabandi, at the 2017 IEEE Antennas and Propagation Society Student Paper Competition, April 2017.



Yektakhah's fabricated imaging system, including: (a) transmitter, (b) receiver and synchronization circuit, (c) A/D module, and (d) low profile wideband CP omnidirectional antenna.

{2003} HERCULES

The 300 TW laser known as HERCULES (High-Energy Repetitive CUos LasEr System) is a table-top size laser that set the world record for high intensity in a laser in 2003; it later broke its own record, which it still holds. A laser with the capability of HERCULES can be used for medical diagnostic tools, and in general scientific settings to measure processes with unprecedented temporal resolution. HERCULES, located in the Center for Ultrafast Optical Science (CUOS), is also capable of probing the interior of highly dense plasmas, which has important implications for nuclear fusion energy and astrophysical research.

{1962} HOLOGRAPHY

Photo courtesy Bentley Historical Library

Prof. Emmett Leith's work in synthetic aperture radar at Willow Run Laboratories during the 1950s led to his fascination with holography, at the time an unproven theory. He and Juris Upatnieks made the theory reality with their novel technique, which they described in a 1962 publication and demonstrated to the world in 1964 with a hologram of a toy train. Holography quickly became a technology with sweeping applications in fields as varied as nuclear materials storage, credit card security, optical data storage, art, and medicine. The breakthrough earned Leith the National Medal of Science.

Breakthrough for Large Scale Computing:

Memory Disaggregation Made Practical

For decades, operators of large computer clusters in both the cloud and high-performance computing communities have searched for an efficient way to share server memory in order to speed up application performance.

Now a newly available open-source software developed by Michigan computer science and engineering researchers makes that practical.

The software is called Infiniswap, and it can help organizations that utilize Remote Direct Memory Access networks save money and conserve resources by stabilizing memory loads among machines. Unlike its predecessors, it requires no new hardware and no changes to existing applications or operating systems.

Infiniswap can boost the memory utilization in a cluster by up to 47 percent, which can lead to financial savings of up to 27 percent, the researchers say. More efficient use of the memory the cluster already has means less money spent on additional memory.

“Infiniswap is the first system to scalably implement cluster-wide memory disaggregation, whereby the memory of all the servers in a computing cluster is transparently exposed as a single memory pool to all the applications in the cluster,” said Infiniswap project leader Prof. Mosharaf Chowdhury.

“Memory disaggregation is considered a crown jewel in large scale computing because of memory scarcity in modern clusters.”

The software lets servers instantly borrow memory from other servers in the cluster when they run out, instead of writing to slower storage media such as disks. Writing to disk when a server runs out of memory is known as “paging out” or “swapping.” Disks are orders of magnitude slower than memory, and data-intensive applications often crash or halt when servers need to page.

Prior approaches toward memory disaggregation – from computer architecture, high-performance computing and systems communities, as well as industry – aren’t always practical. In addition to the new hardware or modifications to existing applications, many depend on centralized control that becomes a bottleneck as the system scales up. If that fails, the whole system goes down.

To avoid the bottleneck, the Michigan team designed a fully decentralized structure. With no centralized entity keeping track of the memory status of all the servers, it doesn’t matter how large the computer cluster is. Additionally, Infiniswap does not require designing any new hardware or making modifications to existing applications.

The research team tested Infiniswap on a 32-machine RDMA cluster with workloads from data-intensive applications that ranged from in-memory databases such as VoltDB and Memcached to popular big data software Apache Spark, PowerGraph, and GraphX.

They found that Infiniswap improves by an order of magnitude both throughput – the number of operations performed per second – and tail latency – the speed of the slowest operation. Throughput rates improved between 4 and 16 times with Infiniswap, and tail latency by a factor of 61.

Infiniswap is being actively developed by CSE graduate students Juncheng Gu, Youngmoon Lee, and Yiwen Zhang, under the guidance of Chowdhury and Kang G. Shin, the Kevin and Nancy O’Connor Professor of Computer Science.

The research that led to Infiniswap was funded by the National Science Foundation, the Office of Naval Research, and Intel. A paper on Infiniswap, titled “Efficient Memory Disaggregation with Infiniswap,” was presented at the USENIX Symposium on Networked Systems Design and Implementation in March 2017.

Vroom! Here Comes a Faster Mobile Web

In late 2016, mobile web traffic surpassed desktop web traffic worldwide. But even on advanced mobile devices and cellular networks, mobile-optimized websites load slowly, often frustrating users. According to Google, 54% of mobile site visits are abandoned if a page takes longer than three seconds to load.

Researchers led by Prof. Harsha Madhyastha have created Vroom, a framework which dramatically accelerates the display of web pages on mobile devices. Vroom comes from a rethink of how clients and servers interact to facilitate web page loads and does not rely on proxies, which might result in less secure connections and break personalization.

Today, even mobile-optimized web pages include roughly one hundred resources on average, and client browsers can discover each of these resources only after they have fetched, parsed, and executed other resources that appear earlier in the page. It is this inefficient sequence of dependencies within the page load process which causes slow load times.

Current solutions either compromise security and privacy by relying on proxies to resolve dependencies or have limited ability to improve mobile web performance since they require clients to themselves discover the resources on any page. Unlike existing solutions, Vroom's key characteristic is that clients fetch every resource directly from the domain that hosts it.

By enabling web servers to aid a client's discovery of resources, Vroom decouples the client's processing and downloads of resources, and does so while preserving the end-to-end nature of the web.

The researchers focused on providing faster load times on news and sports sites since they are more complex than the average site. On the top 50 news and top 50 sports sites, Vroom significantly reduced the median page load time by more than five seconds.

{1959} MICHIGAN ALGORITHM DECODER

Developed in 1959 by Bernard Galler, Bruce Arden, and Robert M. Graham, MAD was a variant of the ALGOL language. MAD ran on the IBM 704 and was widely used to teach programming at colleges and universities during the 1960s. MAD was also used by the Ford Motor Company and in the famous air traffic control system SAGE.

UNIVERSITY OF MICHIGAN BICENTENNIAL

Cryptocurrency With a Malicious Proof-of-Work

CSE graduate student Benjamin VanderSloot and CSE alumnus Eric Wustrow, now a professor of Electrical Engineering at the University of Colorado Boulder, have developed DDoSCoin, a cryptocurrency with a malicious proof-of-work. The researchers hope that this provocative project encourages others to discover and innovate on novel proof-of-resource puzzles.

Cryptocurrencies rely on proofs-of-work that require miners to spend a large amount of effort to solve a specific puzzle. Solutions to these puzzles, on the other hand, are designed to be inexpensive to verify. In this project, the researchers propose a proof-of-work that allows miners to prove they have participated in a distributed denial of service, or DDoS, attack against a particular target. Miners are incentivized to send and receive large amounts of network traffic to and from the target in order to produce a valid proof-of-work.

As with other cryptocurrencies, other individuals can inexpensively verify these proofs, and the original miner can collect a reward. This reward can be sold for other currencies, including Bitcoin or even traditional currencies, allowing botnet owners and other attacks to directly collect revenue for their assistance in a decentralized DDoS attack.

Proof-of-DDoS can be used to replace proof-of-work in a cryptocurrency setting, provided that there is consensus around what victims are valid targets. Cryptocurrency innovation continues to produce new and useful proof-of-work replacements. Still, proving access to arbitrary resources remains a difficult challenge. In this direction, DDoSCoin delivers a novel technique for proving the use of bandwidth to a target domain.

The researchers presented their work at the 2016 USENIX Security Symposium.

Codeon is the Intelligent Assistant for Software Developers

Researchers including Prof. Walter Lasecki have created Codeon, a system that enables more effective task hand-off between end-user developers and remote helpers by allowing asynchronous responses to on-demand requests. With Codeon, developers can request help by speaking their requests aloud within the context of their Integrated Development Environment.

Codeon automatically captures the relevant code context and allows remote helpers to respond with high-level descriptions, code annotations, code snippets, and natural language explanations. Developers can then immediately view and integrate these responses into their code. This makes it easy for developers to make sufficiently detailed requests and send to other developers, making the process quick and effective. Also, Codeon's asynchronous model is more scalable for multiple helpers than synchronous support tools because it allows multiple helpers to work in parallel with the developer.

The researchers found that developers using Codeon completed nearly twice as many tasks as those who used state-of-the-art synchronous video and code sharing tools, by reducing the coordination costs of seeking assistance from other developers.

{1951} MICHIGAN DIGITAL AUTOMATIC COMPUTER

The first digital computer developed at Michigan was The Michigan Digital Automatic Computer (MIDAC), which was built at the University's Willow Run Research Center, an off-campus center devoted to defense research projects. It was a serial machine, operated at 1MHz, and stored 512 45-bit words as circulating pulses in mercury delay lines.

Kurator Will Help You Curate Your Personal Digital Content

People capture photos, audio recordings, video, and more on a daily basis, but organizing all these digital artifacts quickly becomes a daunting task. Automated solutions struggle to help us manage this data because they cannot understand its meaning.

To address this challenge, Profs. Walter Lasecki and Mark Ackerman have helped create Kurator, a hybrid intelligence system leveraging mixed-expertise crowds to help families curate their personal digital content. Kurator produces a refined set of content via a combination of automated systems that are able to scale to large data sets, and human crowds who are able to understand the data.

Kurator leverages the mix of expertise levels between "crowds": families and paid web workers, and has a tiered approach whereby a machine learning classifier performs coarse-grained filtering on a family's entire digital audio collection, and the crowd refines the classifiers' output into a smaller, more manageable set of higher quality recordings that can be presented back to the family. Crowd workers can accurately assess content that parents find sentimental, and their assessments are improved by natural language feedback from the family.

The researchers evaluated Kurator through a user study with five families and they found that not only is the resulting curation useful, but also that crowdsourcing can be applied to an important class of subjectively-based problems. For these problems, they show that Kurator is able to effectively leverage crowds to provide useful assistance.

Also, families found Kurator useful because it was able to provide a more tractable set of results while still discovering important memories.

Kurator serves as a proof of concept for both the viability of intelligent curation support, particularly when structured as a hybrid intelligence system with a tiered architecture, and the potential of crowdsourcing for curation tasks.

Social Interaction Patterns Provide Clues to Real Life Changes

Researchers including Prof. Danai Koutra have explored the dynamics of individual user interactions in social networks by creating iNET, a comprehensive analytic and visualization framework that provides personalized insights into user behavior.

Prior work on user behavior modeling in social networks has focused primarily on the network-wide properties of group behavior within a fixed time interval and aimed to identify users who are outliers or who may deviate from their usual patterns of behaviors.

The researchers focused on the automatic and personalized identification of transitions in online user behaviors. Their work is minimally invasive: It does not focus on the textual information, but rather on when the information is shared.

The identified changes in social media behavior may point to real events and changes, some of which can benefit from intervention.

The researchers' work made two main contributions. They challenged the widely adopted "fixed interval of observation" in favor of a variable interval of observation; and they developed iNET, an analytic framework, to detect and visualize changes in online behaviors of individual users without using their text-based interactions. The researchers used eight different datasets to validate their ideas and techniques, including social media, email, and online forums, and cumulated years of observations and more than a million interactions.

Labeling of the identified changes in user behavior showed that iNET is able to capture a wide spectrum of internal and external events, while the baselines are less diverse and capture only 66% of that spectrum. Also, iNET exhibited the highest precision (95%) compared to all competing approaches

The researchers view their work as a first step towards fully exploring the amount and type of information that can be extracted from the online social footprint of a person. In the future, they hope their research will have a significant societal impact in detecting depression, manic episodes, suicidal tendencies, and cyber-bullying.

CHORUS: The Crowd-Powered Conversational Assistant

Intelligent conversational assistants, such as Apple's Siri, Microsoft's Cortana, and Amazon's Echo, have quickly become a part of our digital life. However, due to the lack of fully automated methods for handling the complexity of natural language and user intent, these services are largely limited to answering a small set of common queries involving topics like weather forecasts, driving directions, finding restaurants, and similar requests. This limits researchers' ability to observe how users really want to interact with the underlying system.

To address this problem, Prof. Walter Lasecki and his colleagues have developed a crowd-powered conversational assistant, Chorus, and deployed it to see how users and workers would interact together when mediated by the system.

Chorus sophisticatedly converses with end users over time by recruiting workers on demand, who in turn decide what might be the best response for each user sentence. The conversational agent is capable of providing users with relevant responses instead of merely search results.

Up to the first month of the deployment of Chorus, 59 users held conversations with Chorus during 320 conversational sessions. The users used Chorus in a variety of different ways including, including brainstorming gift ideas, proofreading a paragraph, and collecting literature for research. The researchers were presented with a number of challenges, including determining when to terminate a conversation; dealing with malicious workers when large crowds were not available to filter input; and protecting workers from abusive content introduced by end users. They also faced challenges with recruiting workers because of cost and workers' preference, and how to continue a conversation reliably with a single collective identity.

The problems that they did encounter during their deployment did not come about in prior lab-based research studies of crowd-powered systems. The researchers believe their observations could assist the deployment of crowd-powered conversation systems, and crowd-powered systems in the future.

Movie Design for Specific Target Audiences

Creating products that satisfy the market is critical to companies as it determines their success and revenue. Online services, such as Amazon, eBay, and Netflix, use data-driven approaches to recommend products to their customers. Currently, experts use their judgment to estimate solutions to designing a new product that will satisfy customers, but this does not scale or allow leveraging massive datasets.

Prof. Danai Koutra and her colleagues sought to identify how they can design new movies with features tailored to a specific user population. Their goal was to design a successful movie that will attract the interest of a targeted demographic by leveraging the large amounts of available data like user ratings, reviews, and product characteristics.

Their research differs from previous studies because it does not aim to find the best existing movies that the target users are likely to enjoy, which is the goal of typical recommendation systems. Instead, given the user preferences, it determines the features (e.g., actors, directors, genre) for a new movie that is likely to attract the largest number of users.

The researchers used real-world data with 5 million movie ratings and 175,000 movie-features, and approached the problem by separating the solution into two phases: user-feature preference inference, and model-based design.

The results showed that their path-based method is highly scalable and effectively provides movie designs oriented towards different groups of users, such as men, women, and adolescents. Also, they showed that their algorithm is superior to baseline methods in terms of movie preference predictions.

Even though they tailored their approach to the design of movies, it can be generalized to other products as long as reviews and product features can be identified. They hope to extend their work in the future to include other elements of the creative movie process, like the plot of the movie, the screenplay, and the soundtrack.

BugMD: Automatic Mismatch Diagnosis for Bug Triaging

Today's microprocessors are incredibly dense, with billions of transistors packed into a design – a design which must be verified to ensure that it is correct. Surprising to most, the majority of the development time of a processor is not design, but rather verification. Bugs that are not caught before a product is released can cost companies billions of dollars. However, even if a bug is detected, the diagnosis of the problem is extremely time and resource consuming as the source of the bug is tracked down. Bugs tend to hide in extremely complex corner cases, often detected long after their occurrence. Engineers engage in a time-consuming, mostly ad-hoc, triaging process to identify the design units responsible for a bug and then carve a unit-level analysis to root-cause it.

To accurately pinpoint the root cause of bugs, a research team including Thurnau Professor Valeria Bertacco, Prof. Scott Mahlke, and CSE graduate students Biruk Mammo and Daya S. Khudia have proposed BugMD, an automatic bug triaging solution that collects multiple architectural-level mismatches and employs a classifier to pinpoint buggy design units. BugMD compares a design's architected state with a golden state from an instruction set simulator to collect multiple symptoms for a single bug in a single test run. These multiple manifestations of bugs form bug signatures that are then passed through a machine learning backend to obtain a prediction of likely bug sites.

To train the machine-learning classifier, the researchers developed a synthetic bug injection framework for generating large training datasets when real, previously diagnosed bug signatures are either unavailable or insufficient. Despite leveraging only architectural-level mismatches without any microarchitectural knowledge, their experiments show that BugMD can identify the correct location over 70% of the time on first try. When considering multiple top candidates, the buggy design unit is among BugMD's top three likely candidates in over 90% of cases.

Researchers Continue Bipolar Research Under New Grant

A multidisciplinary team of researchers, including Prof. Emily Mower Provost, have been awarded a $2.9 million grant from the National Insitute of Mental Health to conduct a five-year research study on suicidality using their smartphone app called PRIORI.

PRIORI, which stands for Predicting Individual Outcomes for Rapid Intervention, records changes in acoustic features of speech (volume, speed, and pitch) as well as patterns of daily smartphone use. These data will be used to estimate risk of suicidal action and ideation.

Control-ling Energy in Earth Friendly Ways

Prof. Johanna Mathieu is striving to find ways to reduce the environmental impact, cost, and inefficiency of electric power systems by inventing new operational and control strategies.

She is particularly interested in developing new methods to actively engage distributed flexible resources such as energy storage, electric loads, and distributed renewable resources in power system operation. This is especially important in power systems with high penetrations of intermittent renewable energy resources such as wind and solar.

To do this, she uses methods from a variety of fields including control systems and optimization. She also uses engineering methods to back up her recommendations on energy policy.

In a newly-funded project, called Computational Energy Systems, she is developing new algorithms for the U.S. electrical power grid that deal with the integration of renewable energy sources, electrification of transportation systems, the increasing frequency of extreme weather events, and other emerging contingencies. The research, funded by the Michigan Institute for Computational Discovery and Engineering, is being conducted in collaboration with faculty in Industrial and Operations Engineering.

Solving the Weakest Link Problem So Solar Panels Can Handle Shade

Shade is a big problem for solar panels. A 10 percent shade cover can create a 50 percent drop in electricity production. A new project led by Prof. Al-Thaddeus Avestruz could dramatically improve that scenario by ensuring that power produced by a solar panel reflects the average over all the cells. The project is funded through the Department of Energy SunShot Initiative.

The reason why a little shade causes large power losses in a solar panel is that the photovoltaic cells are all connected, and the string of solar cells can only maintain the electrical current produced by the shaded solar cells, which are the weakest link in the chain.

The shading effect occurs whenever anything comes between the solar cell and the sun, including dirt, bird droppings, fallen leaves, and snow – and rooftop installations aren't exactly easy to clean. Worse, because the shaded cells resist the current produced elsewhere, they can heat up and damage themselves, crack the solar panel's surface or even start fires, says Avestruz.

To stop this weakest link phenomenon, he and his colleagues are working on a way to allow the cells in full sun help out those in the shade. They will do this by adding extra circuitry that allows the cells to trade charge – if the charges stored in each cell are equal, then the current produced by each cell will also be equal. The impact could be huge.

"Shading is a fundamental issue with photovoltaic systems," explained Avestruz. "Globally, more than 7.8 million kilowatt-hours of electricity are estimated to be lost annually due to photovoltaic shading. This lost energy is enough to power the city of San Francisco for an entire year."

IMPACT on PEV Charging Strategy and Other Electric Loads

Two papers by Ian Hiskens, Vennema Professor of Engineering, have proven to have had a significant impact on later research.

Three years after it was published, the paper:

> "Decentralized Charging Control of Large Populations of Plug-in Electric Vehicles" by Zhongjing Ma (former postdoctoral researcher), Duncan Callaway (former U-M postdoctoral researcher, now an assistant professor at UC-Berkeley) and Ian Hiskens, *IEEE Transactions on Control Systems Technology* (vol. 21, no. 1, January 2013, pp. 67-78)

was the 3rd most highly cited paper over the last five years in the journal.

The paper developed a strategy to coordinate the charging of personal plug-in electric vehicles (PEVs) using concepts from non-cooperative games. The strategy assumes that the individual is allowed to make their own decisions as to when to charge their vehicles. It also provides in incentives so that not everyone ends up charging their vehicles at the same time, which could be catastrophic for the electric grid should everyone own a PEV and decide to plug it in at 6 pm every night, for example.

Five years after it was published, the paper:

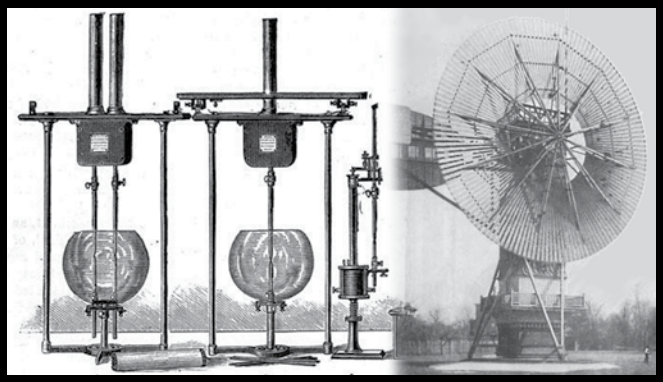
> "Achieving Controllability of Electric Loads" by Duncan Callaway and Ian Hiskens, *Proceedings of the IEEE* (vol. 99, no. 1, January 2011, pp. 184-199)

was the 5th most highly cited paper over the last five years in the journal.

This paper provided an overview of various conceptual frameworks for involving highly distributed loads in power system control actions. In particular, the authors discussed the pros and cons of centralized, hierarchical, and distributed control architectures. The research addressed the anticipated impact of additional sources of power available to the grid from wind and solar power, as well as the impact of new drains on the electrical grid, such as plug-in electric vehicles. The goal is an electric service that meets the needs of all consumers as technology continues to change.

{1879} CHARLES BRUSH

Charles Brush (BSE 1869) installed the first electric light system in the United States in Cleveland, OH in 1879, and founded the Brush Electric Company in 1880. By 1881, his arc light systems could be found throughout the United States, producing public light well into the 20th century. Creator of more than 50 inventions, Brush built the first automatically operated wind turbine generator in 1888 to power his Cleveland mansion.



SNOW SCIENCE IN ACTION

Understanding the changing behavior of ice and snow in different regions is vital to effective freshwater supply management, and it takes accurate remote sensing instruments and techniques to monitor this change. While the gold standard for such monitoring has been microwave radar and radiometer systems, the resulting info about a key metric, called snow water equivalent (SWE), can be skewed when trees are present.

Doctoral student Mohammad Mousavi spent time in Colorado this past February measuring the effect of tree canopies in the brightness temperature of a snowpack in order to better predict and recover the SWE of the snowpack.

The research was conducted under NASA's SnowEx project. Mousavi was one of 100 NASA researchers who could be found testing out their equipment this past winter in the Grand Mesa National Forest. During the coming year, all the data collected will be analyzed and used to plan future airborne and ground data collection.

In related research, Mousavi developed an improved method to measure SWE, called wideband autocorrelation radiometry (WiBAR). The technology offers lower cost, lower power, and more flexibility (i.e., it can work in all weather conditions) than competing methods. The research is part of a project that was developed in collaboration with his advisor, Kamal Sarabandi, Rufus S. Teesdale Professor of Engineering, co-advisor Roger DeRoo (Associate Research Scientist in the Department of Climate and Space Sciences and Engineering), and Tony England, Dean of the College of Engineering and Computer Science at U-M Dearborn.

Mohammad checking out the characteristics of a snowpack.

Mohammad Mousavi measuring snow and water in Colorado as part of NASA's SnowEx project.

Modeling the World's Forests

Forest structure is an important indication of the earth's carbon cycle, which impacts global climate, biodiversity, land use and development, and more. Trees absorb atmospheric CO^2 through photosynthesis and then release it through decomposition. With 30% of the Earth's landmass comprised of forests, scientists need a detailed understanding of their size and makeup to evaluate their overall impact.

There are several primary methods to determine forest structure, each with their own drawbacks. Scientists agree that satellites can provide the data most efficiently, but there are a variety of sensing modalities used to acquire forest structure, with none being best for all types of forests.

Researchers in Electrical and Computer Engineering are working to find a better way to quantify forest structure around the globe. They are developing a methodology that can be used to monitor the Earth's various types of forests (deciduous, coniferous, and mixed) by creating models based on a collection of multi-modal remote sensing data, tracked over time.

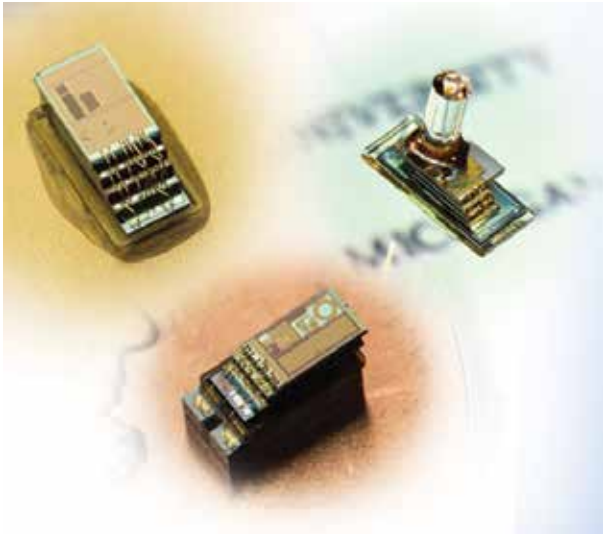
Their research was presented at the 2016 International Geoscience and Remote Sensing Symposium (IGARSS), and selected the following year to receive one of two Interactive Symposium Paper Awards. The paper, "Estimating the three dimensional structure of heterogeneous forests using multi-modal remote sensing and sensor extrapolation techniques," was authored by ECE graduate student Michael Benson, Dr. Leland Pierce, and Benson's advisor, Kamal Sarabandi, Rufus S. Teesdale Professor of Engineering.

Tech Transfer

NEWS

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

Making Millimeter-Scale Wireless Sensor Nodes With Endless Possibilities



CubeWorks has been flying under the radar since 2013, when this startup company specializing in the world's smallest and lowest-power sensing technology was incorporated. 2016 brought the company's first outside funding, from Intel, and now CubeWorks is looking less than two years into the future, when they may be manufacturing millimeter-scale computing devices for their first customers.

"We already have potential long-term customers," said the company's CEO, ZhiYoong Foo (BSE MSE PHD EE 2006 2013), who is looking for customers who want to solve problems with CubeWorks' technology.

What those problems may be is limited only by the imagination. Cubeworks' Cubisens™ platform enables autonomous wireless sensing with millimeter-scale devices. These tiny computing systems are able to sense information about their environment (such as temperature, pressure, or the visual surroundings), and then store and wirelessly transmit the data.

CubeWorks was founded by the team at University of Michigan that developed the Michigan Micro Mote (M^3), the world's smallest computer, in 2014: Prof. David Blaauw, Prof. Prabal Dutta, Dr. Yoonmyung Lee, Prof. Dennis Sylvester, and Prof. David Wentzloff. In addition to Foo, other key members of the company are Dr. Gyouho Kim (Chief Technical Officer) and Yejoong Kim (VP of Research and Development). Current graduate student Pat Pannuto completes the all-Michigan team as principal systems architect.

Movellus Circuits

Movellus has raised over $1M from respected silicon valley investors to bring its patented VirtualAnalog™ to the market. VirtualAnalog™ is disrupting the way semiconductor chips are designed by removing traditionally analog constraints from chip design. According to Dr. Muhammad Faisal, Movellus has developed a groundbreaking technology that will make all of our electronics more efficient and cost effective over the years. Today, customers in the artificial intelligence, Internet-of-Things, and networking space are utilizing Movellus technology in their products.

Movellus was co-founded by Muhammad Faisal (MSE PHD EE 2011 2014), VP of Engineering Jeffrey Fredenburg (BSE MSE PHD EE 2008 2010 2015), and Prof. David Wentzloff in 2014.

Clinc Launches AI Personal Assistant for Banking, Receives $6.3M in Funding

Artificial Intelligence startup Clinc, founded by Profs. Jason Mars and Lingjia Tang along with research fellow Michael Laurenzano and graduate student Johann Hauswald launched a new application called Finie, the financial genie. Finie, which can be referred to as the "Siri" of personal banking, is an artificial intelligence platform for banks that helps customers talk to their bank accounts in a natural and conversational way to get real-time and instant financial insights.

Finie is based on a set of AI engines that were developed by the Clinc team using a data-driven approach. When integrated with a mobile bank application, Finie leverages natural language processing and AI to help users understand their finances. For instance, a user can ask questions such as, "How much money can I spend on groceries?", "How much am I spending on Ubers?", "What's my largest spending this month?" Finie will then provide consumers with immediate, thorough results, which consumers can visualize on their phones via graphs and charts.

Finie is unlike other intelligent personal assistants because consumers are able to speak in a conversational way without a specific guideline or pattern. The platform can also perform a number of other tasks including the transfer of money between accounts or sending money to friends.

Clinc also recently closed a $6.3 million Series A round of financing led by Drive Capital and joined by Hyde Park Venture Partners, Cahoots Holdings and Boston's Stuart Porter. This round brings the total raised to $7.75 million since its founding in July 2015.

"We've had overwhelming interest in Finie from financial institutions covering a wide variety of financial functions," said Prof. Mars, who also serves as Clinc CEO. "The opportunities are truly endless. With this additional capital, our AI will become even more capable. We're going to eliminate the complexity and barriers that consumers typically face when understanding their finances, and we're going to help more consumers connect with their financial data in personalized, impactful ways with minimal effort."

Profs. Lingjia Tang and Jason Mars are Clinc co-founders.

The funding will be used to invest in continued product innovation, to further accelerate the company's rapid revenue growth, and to expand the Clinc team as they execute on their aggressive roadmap and vision to maximize the societal benefits of AI.

Clinc's team, located in downtown Ann Arbor, is now over 20 members and growing.

{1990} PHOTOSHOP CREATED

Thomas Knoll (BSE Physics 1982; MSE CICE 1984) and his brother, John, changed forever the world of media and graphics when they hooked up with Adobe to market their image editing software that they named Photoshop. Tom developed the code instead of working on his doctoral thesis at Michigan after getting a request from John to improve how graphics were displayed on his new Macintosh. Tom continues to play a central role in the continuing evolution of Photoshop.

100 Million Strong: Security Milestone for the Web Reached

The Internet is more secure thanks to Let's Encrypt, the certificate authority founded by Prof. J. Alex Halderman and his collaborators. As of June 28, 2017, Let's Encrypt has issued 100 million security certificates.

Let's Encrypt provides users with free, automated service that issues the digital certificates that they need in order to enable HTTPS (SSL/TLS) for websites.

Security has become one of computing's most important issues, and a secure web is critical. According to Prof. Halderman, "Anything you access over HTTP travels over the Internet completely unencrypted and unsecured. An attacker can read it, change it, or lie about who's on the other side of the connection." This exposes web users to threats that range from surveillance to phishing and identity theft.

Since its public launch in December 2015, Let's Encrypt has grown to have a significant impact on the security of the web. By September 2016, it had become by some measures the world's largest certificate authority, having issued more than 10 million certificates. Now, Let's Encrypt has issued over 100 million certificates. This demonstrates the strong demand for their services, the organization's ability to scale, and the power of automated certificate management.

When Let's Encrypt's service first became available, less than 40% of page loads on the Web used HTTPS. It took the Web twenty years to get to that point. In the 19 months since Let's Encrypt launched, encrypted page loads have gone up by 18%, to nearly 58%, an incredible rate of change for the Web.

Startup Licenses Mobile Learning Apps for K-12

Collabrify.IT, the e-learning firm co-founded by Thurnau Professor Elliot Soloway, has licensed applications designed in Soloway's U-M-based Intergalactic Mobile Learning Center (IMLC) through the Office of Technology Transfer and is working with commercial partners to make suites of collaborative learning applications available to educators worldwide.

In a world where expensive, printed textbooks no longer fit students' expectations and most students or school districts own mobile computing devices such as phones or tablets, Collabrify.IT is meeting today's students' educational needs through two suites of tools.

One suite of web-apps enables students to draw, write, animate, chart, and map data for experiential, collaborative learning. Actions taken on one mobile device are shared in real-time with other devices in a student's group, allowing student teams to share information and learn together, and then to present their findings.

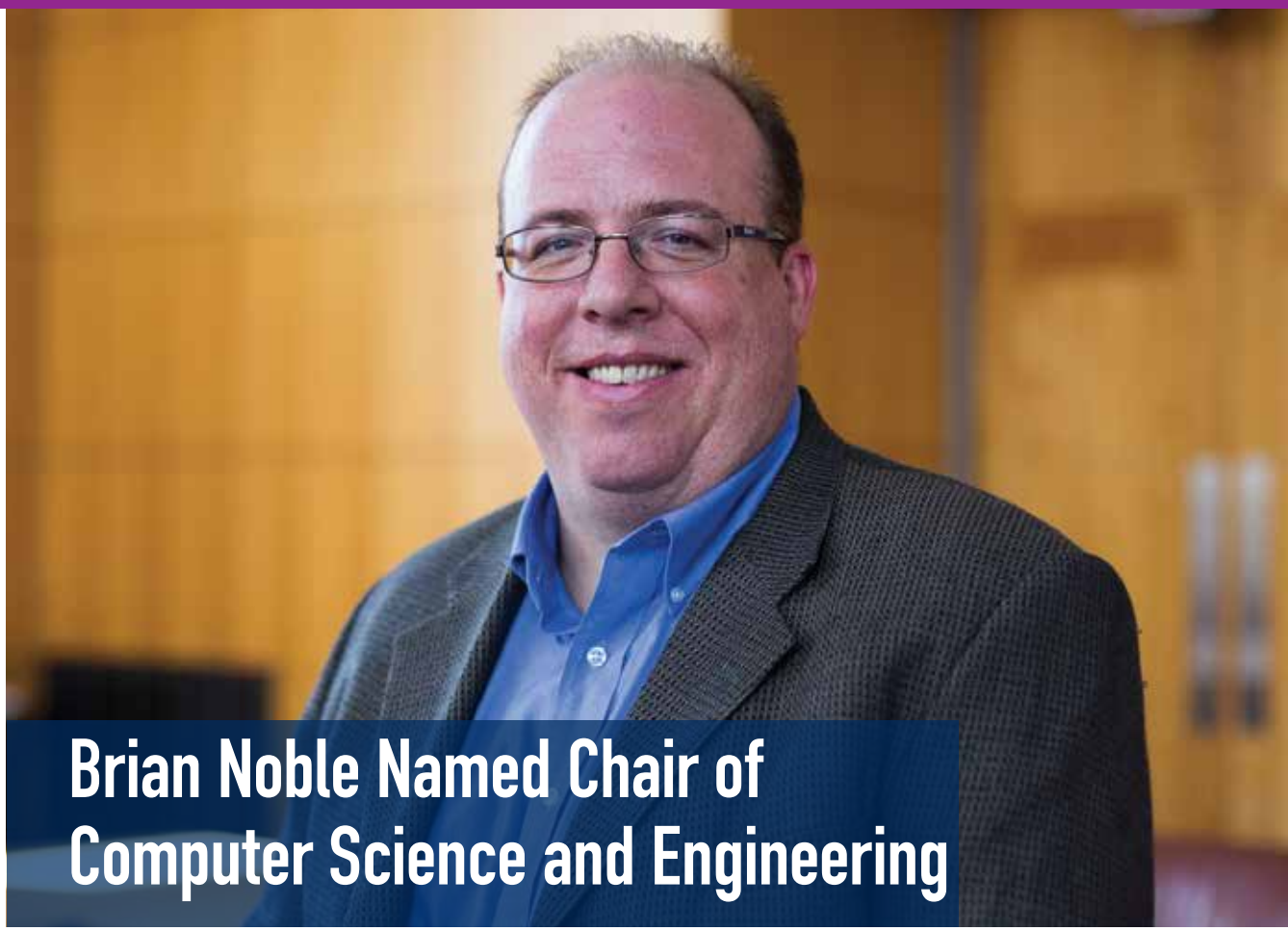
The other suite enables K-12 teachers to manage deeply-digital curriculum – creating lessons from OER – Open Education Resources – distributing those lessons, monitoring student enactment in real time, assessing student-produced artifacts, and finally sharing digital lessons in a PLN – professional learning network.

"From problem to solution, from theory to practice, it is exciting to see how IMLC and Tech Transfer are making the fruits of research available, on a daily-basis, to teachers and students, worldwide," says Prof. Soloway.

{1998}

In 1998, at the age of 26, Larry Page (BSE CE 1995) co-founded Google, Inc. and changed the world with his remarkable search engine. At Michigan, Larry Page was President of Eta Kappa Nu (HKN), the national honor society for electrical and computer engineers. He participated in LeaderShape, and earned leadership awards for his efforts to improve the environment for all engineering students. Now CEO of Alphabet Inc., he's still committed to helping get the world the information it seeks as easily as possible, while finding other ways to improve life for all.

Department NEWS



Brian Noble Named Chair of Computer Science and Engineering

Prof. Brian Noble has taken the reins as the new chair of the Computer Science and Engineering division of EECS. Noble became chair July 1, 2017, after completion of a nationwide search.

Noble, who has been on the faculty since 1998, is “an advocate for multidisciplinary and experiential learning, and a champion for diversity, equity, and inclusion,” according to Alec D. Gallimore, the Robert J. Vlasic Dean of Engineering.

Noble served as associate dean for undergraduate education (ADUE) at the College of Engineering from 2013 until becoming CSE Chair this year. Under his leadership as ADUE, the College enhanced the opportunities and overall experience available to undergraduate students, which included the launch of an interdisciplinary undergraduate program in the rapidly-growing area of data science with the U-M College of Literature, Science and the Arts. Also under Noble’s tenure, the College’s Multidisciplinary Design Program – which offers hands-on opportunities for students to work on projects with others outside their fields – expanded to 1,600 students, more than 180 projects, and 70 sponsors. Participation in the International Programs in Engineering has increased by 50 percent.

“It’s an honor to serve the CSE faculty, staff, and students in this role,” Noble said. “This is an exciting time for the discipline, with unprecedented demand for our educational programs and researchers on campus and beyond. The CSE Division has an ambitious agenda, and I’m working to help our faculty, staff, and students achieve it.”

A dedicated educator, Noble has been recognized with multiple teaching awards for his work in the classroom.

$75-Million Robotics Hub Gets the Go-Ahead

Robotic technologies for air, sea, roads, factories, hospitals, and homes will have tailored lab space in the University of Michigan's planned Robotics Building. The Board of Regents approved the schematic design for the $75-million facility on September 15, 2016. The robotics hub is slated for a site on the northeast corner of North Campus in the College of Engineering. The 140,000-square-foot building will house a three-story fly zone for autonomous aerial vehicles, an outdoor obstacle course for walking robots, and high-bay garage space for self-driving cars, among other features.

Michigan Robotics is directed by ECE professor Jessy Grizzle. Grizzle is is the Elmer G. Gilbert Distinguished University Professor, the Jerry W. and Carol L. Levin Professor of Engineering, and in addition to his appointment in Electrical Engineering and Computer Science, holds a courtesy appointment in Mechanical Engineering.

ECE Expeditions

The ECE Expeditions is a new initiative brainstormed by the ECE Council to give electrical and computer engineering students the opportunity to learn more about what they might do in a future career in industry. This past year, students visited companies in Detroit and Silicon Valley.

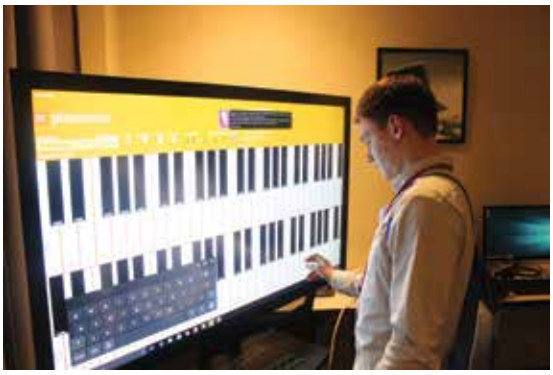
Students overwhelmingly enjoyed the interactive components of the visits. They also loved hearing about the personal experiences and professional paths of the alumni CEOs and engineers they met.

Most of the companies were founded and/or are currently run by ECE alumni.

STUDENT COMMENTS:

"It opened my eyes to many more career possibilities and the idea that career plans may change quickly and often."

"I had no idea a majority of these opportunities existed and it's cool to see. I look forward to utilizing this to further my studies."



Ann Arbor Expedition (Fall 2016)

Companies visited:

NeuroNexus: Brain interface devices and systems

Quantum Signal: Product design, consulting, R&D for robotics, video, forensics, and biometrics

Menlo Innovations: Consulting with a specialty in software design and development

Silicon Valley Expedition (Winter 2017)

Companies visited:

8x8: Communications Cloud

ARM: Semiconductor IP company, energy-efficient microprocessors

Cavium: Integrated semiconductor processors for intelligent processing

Cisco Systems: IT and networking

Exponent: Engineering and scientific consulting firm

KLA-Tencor: Products for the semiconductor, data storage, LED and nanoelectronics industries

Synaptics: Human computer interface semiconductors and software

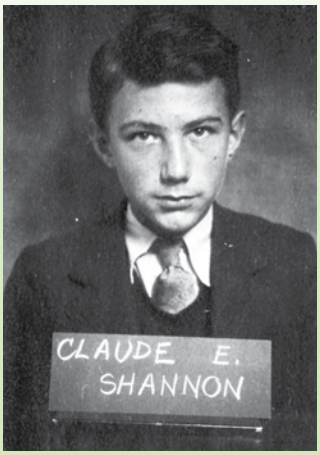
Shannon Centennial Symposium:

Celebrating the Father of Information Theory

Researchers from around the nation gathered at U-M to celebrate the 100th birthday of alumnus Claude E. Shannon (BSE EE/Eng Math '36, ScD hon. '61) at the Shannon Centennial Symposium on September 16, 2016. The event was co-organized by Alfred Hero (the John H. Holland Distinguished University Professor and R. Jamison and Betty Williams Professor of Engineering), Dr. Hye Won Chung, Dave Neuhoff (the Joseph E. and Anne P. Rowe Professor of Electrical Engineering) and Prof. Sandeep Pradhan.

The celebration continued throughout the rest of the year with the Shannon Centennial Seminar Series, a special series of Communications and Signal Processing lectures welcoming experts from around the nation to talk about current work building on Shannon's theories.

Co-organizers and invited lecturers: Sandeep Pradhan, Alfred Hero, Michelle Effros, Abbas El Gamal, Hye Won Chung, Emmanuel Candes, David Neuhoff, Robert Calderbank

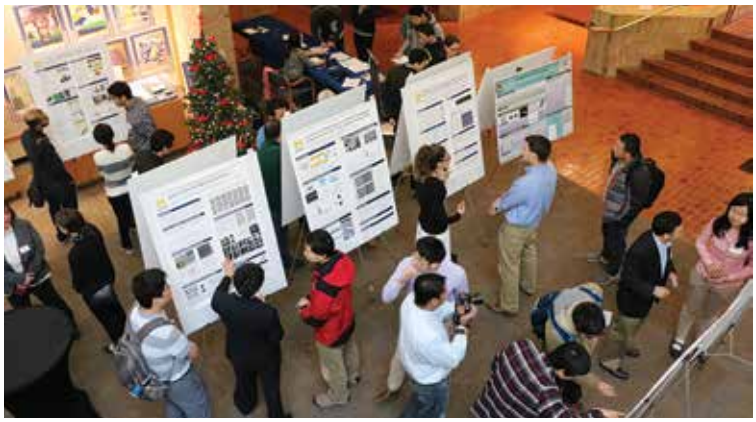


Claude E. Shannon's registration photo from his time as a student at Michigan.
Photo courtesy Bentley Historical Library, University of Michigan

Celebrating LNF Innovation

The 2016 Lurie Nanofabrication Facility (LNF) User Symposium highlighted the cutting-edge research enabled by Michigan's world-class facility. The Symposium included technical talks, a poster session, the opportunity for discussion and networking, and a keynote address by Mark Kushner, George I. Haddad Professor of EECS, titled "The Role of Plasma Modeling in the Innovation Cycle for Nano-Fabrication."

Mark Kushner delivering the keynote address



C-FAR Researchers Share Info at Ann Arbor Meetings

The Center for Future Architectures Research (C-FAR) held two successful meetings of faculty, students, and industry sponsors from across the nation this past year. December 2016's Annual Research Review featured demos of 49 student research projects. Industry and faculty attendees voted for the top demos, awarding the top prize to "Compute Caches" by U-M's Shaizeen Aga, Supreet Jeloka, Arun Subramaniyan, Satish Narayanasamy, David Blaauw, and Reetuparna Das. A short video filmed at the demo session in which center directors, students, and sponsors explain how C-FAR demos connect them with industry and other academics is available at https://www.futurearchs.org/video-2016-annual-review.

At May 2017's Semi-Annual Meeting, researchers attended workshops on emerging technologies, security, and metricizing research.

U-M PhD Candidate Salessawi Yitbarek demos his research on cold-boot attacks.

Prof. Halderman presents on the 2016 presidential election and security concerns.

Science on Screen Event Highlights Electronic Voting

On the cold winter night of Wednesday, January 25, 2017, the CSE and local Ann Arbor communities turned out for a special screening of the documentary *I Voted?* at downtown Ann Arbor's Michigan Theater. The film was followed by a lecture by Prof. J. Alex Halderman on security risks in America's election system and his analysis of the results from the 2016 presidential election recounts, which he helped to organize. Both the film and the lecture had a clear impact on the audience, inspiring urgent buzzes of conversation.

Students associated with the CSE's graduate and undergraduate programs were able to attend the event for a discount with a voucher from CSE. Many turned out, along with faculty, staff, and hundreds more from the local community.

I Voted? is a documentary that asks questions about America's voting process. It highlights the work of noted computer scientists who are working in the area of election integrity, including Prof. Halderman.

Optics and Photonics Industry Snapshot

The keynote speaker was Prof. Emeritus James C. Wyant, former Dean of the College of Optical Sciences, University of Arizona and founder of both WYKO Corporation and 4D Technology Corporation.

Event organizers, pictured above, included alumna Michelle Stock (far left, back); research scientist John Nees (far right, back); and ECE PhD students Elizabeth Dreyer and Victoria Zhang (front right, respectively)

Professionals and researchers from across Michigan's optics industry gathered for the Optics and Photonics Industry Snapshot on March 27, 2017, to celebrate both the 100th anniversary of the Optical Society of America (OSA) and the 50th anniversary of the Ann Arbor Section of the OSA. Organizers of the event included ECE alum Michelle Stock, research scientist John Nees, and PhD students Elizabeth Dreyer and Victoria Zhang.

Eighteen industrial and academic exhibitors and sponsors provided demos and presentations, as well as company materials for students seeking employment.

6th Midwest Workshop on Control and Game Theory

April 22-23, 2017 University of Michigan

In April 2017, Michigan hosted the 6th Midwest Workshop on Control and Game Theory. The workshop brought together researchers, students, and faculty who develop and apply game and control theory to analyze, design, and assess complex systems.

Topics discussed included game theory and applications, mechanism design, adaptive and nonlinear control theory, hybrid and switched systems, networked control systems, large-scale and distributed optimization, and applications.

Members of the organizing committee included (all from EECS unless otherwise indicated): Kira Barton (Mechanical Engineering), Mingyan Liu, David Miller (Economics), Gabor Orosz (Mechanical Engineering), Necmiye Ozay, Dimitra Panagou (Aerospace Engineering), Grant Schoenebeck, and Vijay Subramanian.

The workshop was sponsored by the Department of Electrical Engineering and Computer Science, U-M Rackham Graduate School, ADVANCE Program, Michigan Engineering, Michigan Research, Mechanical Engineering, Aerospace Engineering, Michigan Institute for Teaching and Research in Economics, Economics, Complex Systems, Ford Motor Company, and the National Science Foundation.

{1959} JOHN H. HOLLAND: FIRST PHD IN COMPUTER SCIENCE AT MICHIGAN

The first PhD in Communication Sciences (the prelude to the CSE graduate program) was awarded to John H. Holland, whose thesis was in automata theory, in 1959. Holland would become one of the first professors in the Computer and Communication Sciences Department and would twice serve as Acting Chair in the 1970s. He played roles in founding the Santa Fe Institute and the U-M Center for the Study of Complex Systems.

For First Time, Design Automation Conference Technical Program Committee Meetings Held in Michigan

The Design Automation Conference (DAC) is recognized as the premier conference for design and automation of electronic systems from silicon chips to embedded systems with a broad range of application domains, including automotive and security. The conference, in its 54th edition for 2017, attracts 7,000 attendees yearly and was held in June.

In preparation for the conference, which typically hosts about 300 technical presentations and sessions, the DAC Technical Program Committee met on February 9, 2017 at Detroit Metro Airport. 190 individuals from all over the world were in attendance.

Arthur F. Thurnau Professor Valeria Bertacco, Technical Program Chair for the 2017 conference, chose Michigan as the meeting location. Bertacco said she was motivated “to bring the top experts in my field to Detroit to open them to experiencing Michigan. They usually experience only Silicon Valley.”

Michigan has one of the largest and strongest electronic design automation (EDA) research groups in the world. It has been the top U.S. institution for total publications in top-tier architecture, circuit, and computer-aided design conferences (ISCA, MICRO, ISSCC, VLSI, DAC, DATE) for the past twelve years, with over 70,000 citations since 2011. Two major research centers, the ARM Research Center and the Center for Future Architectures Research, are housed in CSE at Michigan.

Women in Computing

CS KickStart Gives First-Year Students an Introduction to Computer Science

Students and instructors from the CS Kickstart workshop for first-year students.

Just before Fall classes in 2016, the department sponsored the first-ever CS KickStart, a week-long program designed to encourage first-year female students without prior programming experience to consider studying computer science. The program was free for first-year engineering students and gave over 20 students, selected from a pool of 100 applicants, the opportunity to learn how to code, to connect with other students and faculty, and to explore potential careers in computer science.

PhD student Meghan Clark, who founded CS Kickstart, said, "Women need computer science. CS jobs are fast-growing, high-paying, and stable. Additionally, computer scientists help build the systems that influence the changing structures of society. By missing out on computer science, women are missing out on financial opportunities and a voice in shaping the future. I see CS KickStart as a case study to illustrate that small interventions at the right time can have a big impact on the gender gap. We are doing a thorough evaluation to see what longitudinal effects CS KickStart has on participants."

CS Kickstart was organized and run by Clark, fellow PhD students Nilmini Abeyratne, Laura Wendlandt, and Cathy Finnegan-Dollak, and CS undergraduate student Katie Hennell. The faculty advisor for CS Kickstart was Prof. Rada Mihalcea. CS Kickstart will be held again in late summer 2017.

CSE Recognized for Efforts Aimed at Recruiting and Retention of Women in Computing

The CSE Division has been recognized by the National Center for Women & Information Technology (NCWIT) for the depth and breadth of its efforts to recruit and retain female students in its undergraduate computer science programs. Underrepresentation of women in computer science is an issue nationally.

CSE was recognized for its comprehensive program with an NCWIT Extension Services Transformation Award, which is intended to encourage and fund further programs in this area.

CSE's recruiting program has focused on reaching undeclared students and through multifaceted web/print/campus banner promotional campaign, as well as through a redesign of the introductory computing course, EECS 183. Retention efforts include the use of relevant and interesting course content, collaborative learning, timely feedback, and student encouragement through their first four computing courses (EECS 183, 203, 280, and 281). CSE also implemented bias training for course staff and students, and tries to maintain a 50/50 ratio of male and female teaching assistants.

Collegiate Lecturer Dr. Mary Lou Dorf and Prof. Valeria Bertacco have led and built upon these efforts since initiating them in 2012.

Women in Computing Industry Panel

On April 19, 2017, Prof. Rada Mihalcea, the Girls Encoded group, and the U-M Business Engagement Center hosted women in key computer science positions at Duo Security, Google, IBM, Stryker, and Toyota Research Institute to motivate and inspire current students about their upcoming careers.

The event, called Women in Computing: There Are No Limits, consisted of five women panelists who shared stories about their journeys in the computer science field and encouraged students not to settle for a job or company that isn't right for them, to find a role that grows their current skills, and to take risks.

Inspiring a New Generation of Women Engineers in Liberia

Six women engineering students from Liberia traveled to the U.S. to attend the Society of Women Engineers (SWE) Women in Engineering 2016 conference, under the sponsorship of the Excellence in Higher Education for Liberian Development (EHELD) program and U-M-SWE.

These women are hoping that creating their own chapter of SWE will help strengthen the women facing unrelenting discrimination. “Women can contribute to Liberia’s development as much as men,” said Liberian student Quinnetta Clement, “There are a lot of people that have the passion and ability, but they don’t have the confidence to move. We believe that working as a team will help us. If you’re a female at the school of engineering, you have someone to rely on.”

Liberian students visited the U-M campus following the Women in Engineering 2016 conference. L to R: Catherine Merchant, Edith Tarplah, Liz Dreyer (a member of Grad-SWE at U-M), Quinnetta Clement, Littie Pajibo

Welcoming Climate

Herbert Winful, Arthur F. Thurnau Professor, is chairing the Committee for an Inclusive Department, established during the Fall of 2016. The goal of the committee is to make the department an even more inclusive, equitable, and welcoming place for all, and especially for groups that are traditionally underrepresented in Electrical and Computer Engineering. Their efforts have already led to a 100% increase in the number of underrepresented minorities entering our PhD program this fall. In addition, the committee received a Faculty Allies Diversity Grant from the U-M Rackham Graduate School. Among other things, this will allow the establishment of the Willie Hobbs-Moore Lecture Series.

A Bridge to Opportunity

Duncan Steel, Robert J. Hiller Professor, received recognition from the Alfred P. Sloan Foundation for work advancing minority students in STEM. Through the Imes-Moore Bridge Program, Steel worked with master’s students to prepare them for doctoral studies in interdisciplinary research in engineering, applied physics, and the physical sciences.

{1958} WILLIE HOBBS MOORE: FIRST IN EE

Willie Hobbs Moore (1934-1994) made history as the first black woman to earn a BS and MS in Electrical Engineering (1958 and 1961) at Michigan, and the first black woman in the country to earn a PhD in physics. She did spectroscopic research on proteins at Michigan until 1977 before joining Ford as an assembly engineer. She expanded Ford’s use of Japanese engineering and manufacturing methods. Known for her efforts as a tutor of math and science, Michigan established the Willie Hobbs Moore: Aspire, Advance, Achieve Award in her honor.

Lunar New Year

ECE celebrated the Chinese New Year on February 3, 2017 with cooking demonstrations, dance performances, calligraphy, and more!

Nowruz Celebration

Over 200 ECE students and faculty celebrated Nowruz, the Persian New Year, on March 21, 2017 with traditional food, calligraphy, and musical performances.

Dia de Los Muertos

ECE students enjoyed churros November 1, 2016 to celebrate this traditional Mexican holiday.

Distinguished Diversity Leaders Team Award

Seven staff members from Electrical and Computer Engineering received the Distinguished Diversity Leaders Team Award, established to shine a light on those staff members who have shown “extraordinary commitment and dedication to diversity at U-M.” These individuals are involved in student recruiting, retention, and climate.

L-R: Kevin Calhoun (MS Program Coordinator), Lisa Armstrong (Department Manager), José-Antonio Rubio (PhD Program Coordinator), Steven Pejuan (PhD Program Coordinator), Rose Anderson (Graphic Designer), Jason Davis (Alumni and External Affairs), Ann Stals (Event Planning)

{1983} NUCLEAR SAINTS

Photo courtesy Bentley Historical Library

In the early 1980s, a group of students formed the Progressive Student Network (PSN) in protest of government-funded research, which they saw as supporting the military. In protest against the PSN protesters, who invaded Prof. Tom Senior’s lab in 1983, a group of students held their own protest. In their manifesto, they wrote, “At this moment, 15 members of the Nuclear Saints of America have entered the laboratory of the Prophet Professor Thomas B.A. Senior to do military research, and they will not leave until they get some done.”

UNIVERSITY OF MICHIGAN BICENTENNIAL

ECE Family Fun Night

Hundreds of students, alumni, faculty, and friends came together for games and exciting displays at the 2nd Annual ECE Family Fun Night. Attendees of all ages brought the EECS atrium to life in an evening of science, robots, and more that highlight the unique contributions of electrical and computer engineering to our world.

Middle School Students From Peace Neighborhood Center Tour CSE Robotics Lab

In April 2017, middle school students from the Peace Neighborhood Center, a nonprofit that provides programs for children, families, and individuals who are affected by social and economic problems, had the opportunity to tour Prof. Chad Jenkins' Robotics lab in the Beyster Building.

Jenkins showcased two robots, one that was able to move around its environment and pick up objects, as well as an autonomous robot that had a sensor with a camera and the ability to drive over small obstacles.

During the lab tour, students were excited about computer science and potentially pursuing a career in the field in the future.

MARLO

MARLO gets lots of attention from visitors of all ages who come to witness one of the smoothest and smartest walking robots around! Her owner, Prof. Jessy Grizzle, and his students always strive to educate and entertain.

In this photo, the children are trying to make MARLO fall down, and are finding out how her powerful algorithms keep her standing.

High School Students Experience High Tech and Michigan

A select group of high school students spent a week in classes, labs, and even toured the Big House, as they came to Electrical and Computer Engineering to learn just a few things that go on in ECE at the Electrify Tech Camp. This year, they raced their hand-built solar-powered cars, used electronic circuits to channel power, and programmed a microcontroller to control wireless devices. They interacted with faculty and graduate students, and even got the skinny about life at Michigan from current undergraduate students in electrical and computer engineering.

Summer Fun at MiBytes Computer Camps

MiBytes, the annual series of computer camps run by the CSE Division, was held on North Campus and in Downtown Detroit for a summer of new and exciting experiences. This year high school students created their own mobile apps, explored robotics, created their own video games, and programmed drones. The campers had the opportunity to learn from CSE faculty, students, and learn more about the computer science field via field trips to local tech companies.

NEW COURSES

As technology changes and advances, so does our coursework. In addition to constant upgrades to core courses, the following new courses have been introduced over the past year.

ADVANCED TOPICS AND THE DESIGN OF POWER ELECTRONICS *(EECS 598; Prof. Al Avestruz)*
Address some advanced topics and techniques in power electronics and the craft of design through case studies, including switched capacitor circuits, resonant power conversion, magnetics, wireless power transfer, and instrumentation.

BEYOND CMOS: EMERGING NANOTECHNOLOGIES *(598; Prof. Becky Peterson)*
Survey the devices, circuit architectures, and integration challenges facing the semiconductor industry in the "More than Moore" era.

CHANNEL CODING THEORY AND APPLICATIONS *(EECS 650; Prof. Hessam Mahdavifar)*
Coding theory is the science of the systematic study of structured sets called codes, providing reliable communications and data storage in noisy environments.

FORMAL VERIFICATION OF HARDWARE AND SOFTWARE SYSTEMS *(EECS 598; Prof. Karem Sakallah)*
Explores the latest advances in automated proof methods for checking whether or not certain properties hold under all possible executions of a complex hardware or software system.

GRID INTEGRATION OF RENEWABLE ENERGY SOURCES *(EECS 498; Prof. Ian Hiskens)*
Grid integration of wind and solar (photovoltaic and thermal) technologies, and methods of accounting for renewable uncertainty in optimal generation.

INFORMATION SCIENCE *(EECS 398; Prof. Clayton Scott)*
Distills and explains the most important concepts and insights at the core of the information and communications technology revolution.

INTRODUCTION TO ALGORITHMIC ROBOTICS *(EECS 498; Prof. Dmitry Berenson)*
Introduction to the algorithms that form the foundation of robot planning, state estimation, and control. Topics include optimization, motion planning, and position control.

INTRODUCTION TO DISTRIBUTED SYSTEMS *(EECS 498; Prof. Harsha Madhyastha)*
Introduces core principles and techniques that enable low latency and high throughput, maximize reliability, and preserve consistency semantics.

LASER PLASMA DIAGNOSTICS *(EECS 598; Prof. Louise Willingale)*
Discuss the techniques used for creating, characterizing, and timing high-power laser pulses to both create and diagnose high-energy density systems.

MOTION PLANNING *(EECS 598; Prof. Dmitry Berenson)*
Learn the major topics of robotic motion planning including planning for manipulation with robot arms and hands, mobile robot path planning, multi-robot path planning, and planning on constraint manifolds.

OPTICS AND QUANTUM SPECTROSCOPY OF SEMICONDUCTORS *(EECS 598; Prof. Mack Kira)*
A pragmatic and brief introduction to solid-state theory, many-body formalism, and semiconductor quantum optics to explore pragmatic possibilities for nanotechology.

ORGANIC ELECTRONICS: FUNDAMENTALS *(EECS 598; Prof. Stephen Forrest)*
Trace the history, science, and modern applications of organic electronic technology, and learn to develop an understanding of the fundamentals of organic semiconductor materials.

POWER SYSTEM DYNAMICS AND CONTROL *(EECS 598; Prof. Ian Hiskens)*
Introduction to angle and voltage stability concepts and consider control strategies for improving dynamic performance.

QUANTUM INFORMATION, QUANTUM PROBABILITY AND QUANTUM COMPUTING *(EECS 598; Prof. Sandeep Pradhan)*
Extended introduction and overview of the field of quantum information, quantum probability, and quantum computing.

SELF-DRIVING CARS: PERCEPTION AND CONTROL *(EECS 498; Prof. Matthew Johnson-Roberson)*
Learn the theoretical underpinnings of self-driving car algorithms and the practical application of the material in hands-on labs. Highlights will include field trips to the Mcity testing grounds.

THEORY AND PRACTICE OF DATA COMPRESSION *(EECS 553; Prof. David Neuhoff)*
A broad introduction to the theory and practice of lossy compression, where perfect reproductions are not possible, and some introduction to lossless compression.

VLSI FOR SIGNAL PROCESSING AND COMMUNICATION SYSTEMS *(EECS 598; Prof. Hun-Seok Kim)*
Survey methodologies to design energy efficient and/or high-performance VLSI systems for the state-of-the-art image/audio processing, machine learning, and wireless communication systems.

Computing Programs GROW

Computer Science Program in LSA Sees Close to 6X Growth

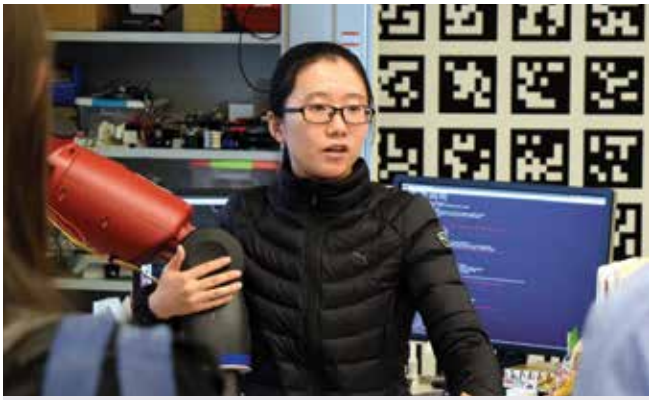
Undergraduates in the College of LSA have long been able to declare computer science as their major; the CS undergrad program was founded in LSA in 1961, and the engineering program was not formed until 2000.

However, enrollment growth in CS from 2000 to 2012 took place primarily in the newer engineering program. Since an awareness program began in 2012, the LSA program experienced rapid growth as well, with the number of declared majors jumping from 64 in Winter 2012 to 373 in Winter 2017.

EECS 280 Becomes Third Largest Course at U-M

With almost 1000 students enrolled during the Winter 2017 semester, EECS 280: Programming and Introductory Data Structures, a core CS class, has grown to have the third-largest enrollment of any course taught at Michigan. Driven by record demand for computer science courses generally, enrollment in EECS 280 has increased by almost 200 students since 2016.

Most of the students who complete EECS 280 go on to graduate with a degree in computer science. CS is currently the most popular undergraduate program in the College of Engineering, with 1017 declared undergraduate majors as of Winter 2017, and this number is reflected in the large sizes of many EECS courses.



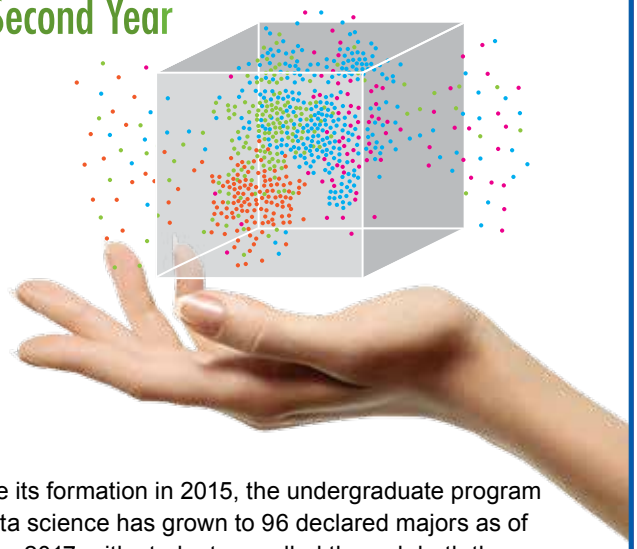
CSE Grad Studies Workshop Increases Profile of Graduate Program

The CSE Division has hosted an annual workshop since 2014 that allows prospective students from institutions around the country to learn about the graduate school application process and the opportunities that exist for those who pursue graduate work in the field of Computer Science and Engineering.

Attendance at the workshop has grown each year, and it is credited with increasing the number of applications received by the graduate program, which reached a record level in 2017.

The 2017 workshop included a Q&A panel with current grad students, live demos of ongoing research, lunch with faculty and grad students, a panel on industry vs. academia, a clinic for how to write a statement of purpose, and one-on-one feedback from faculty regarding applications.

Undergraduate Program in Data Science Grows to Almost 100 Declares in Second Year



Since its formation in 2015, the undergraduate program in data science has grown to 96 declared majors as of Winter 2017, with students enrolled through both the College of Engineering and the College of LSA.

MichiGames Arcade Spotlights and Preserves Student-Built Video Games

There's an active and long-standing video game development community right here at the University of Michigan.

Student game designers have been building games for years through student group Wolverine Soft and in the EECS Department's capstone course, EECS 494 – Computer Game Design and Development.

Now, a new platform has been introduced to showcase and archive these student-made video games. It's called the MichiGames Arcade, and it's located in the Fred C. Shure Lounge and Learning Center on the first floor of the Bob and Betty Beyster Building. The arcade is curated by former Wolverine Soft president, current CSE graduate student, and EECS 494 instructor Austin Yarger.

At its launch in February 2017, the MichiGames Arcade hosted five selected games; three were developed as class projects in the Fall 2016 semester of EECS 494, and two were built during Wolverine Soft's January 13-15, 2017 Game Jam, an event in which student teams compete to build complete games in 48 hours. As of June 2017, Yarger has added an additional game from EECS 494.

According to Yarger, "As of June over 1,100 game sessions that have been played on the arcade, and every game, with the exception of the newly added title, has been played over 100 times."

Yarger has also upgraded the system so that game developers are sent weekly reports about their game's performance, including how many people are playing, game stability, average session length, and more.

Students Veronica Lau, Henry Wang, and Edgar Hu take time for a game on the MichiGames Arcade.

Prehistoric Panic is the latest addition to the arcade; in this cooperative four-player game, cave-people frantically try to collect resources and escape ever-encroaching lava.

{1910–47} DYNAMO LAB

The dynamo was the first electric generator powerful enough to run industrial equipment and facilities. Later power generators were based on their design – including the alternator and electric motor. The Dynamo Lab, located in the West Engineering Building, was the Department's main lab facility from 1910-1947. One of the first courses offered by the department was in dynamo-electric machinery.

UNIVERSITY OF MICHIGAN BICENTENNIAL

EE Senior Co-Develops a Freshman Course Spotlighting Space Science

EE undergraduate student Arun Nagpal, co-president of Students for the Exploration and Development of Space (SEDS), helped develop and then taught a new freshman engineering course called Electronics for Atmospheric and Space Measurements.

He developed the course with Prof. Aaron Ridley (Department of Climate and Space Sciences and Engineering), and worked on the labs with EE Master's student and graduate student instructor Abbhinav Muralidharan. Abbhinav led the printed circuit board (PCB) design and fabrication lectures and labs.

Arun is an electrical engineering student with a passion for space. He helped develop labs that would expose students to the electrical and software skills they need to design an atmospheric instrument. In particular, students learn the principles of sensing, coding, and microprocessor theory. In addition, they get experience soldering components and processing the data received.

According to Arun, the students especially enjoyed fabricating their own PCBs and participating in a high altitude balloon launch.

"I wanted to introduce freshmen to the idea that the atmosphere is a living, breathing thing of scientific interest."

— Arun Nagpal

Photo courtesy NASA

EE undergrad Arun Nagpal, CLaSP Prof. Aaron Ridley, and EE Masters student Abbhinav Muralidharan

{1905–1915} COMMUNICATIONS IN THE EARLY 1900'S

Photo courtesy Bentley Historical Library

In 1901, Prof. George Patterson taught a course entitled "Telephone and Telegraph" for the first time. Between 1905 and 1915, the number of courses offered in the department doubled from 16 to 32, and coursework in communications accounted for many of these new classes. Prof. Lyman F. Morehouse (BSE MSE 1897 1904) was largely responsible for building up this area. Morehouse joined AT&T in 1910, and was responsible for vastly increasing the distance of telephone transmission while improving clarity. His 1920 patent was key to telegram communication in WWI.

UNIVERSITY OF MICHIGAN BICENTENNIAL

Faculty

New Faculty

NEWS

ROYA ENSAFI
Research Assistant Professor
PhD, Computer Science, 2014
University of New Mexico

Roya's research is in the area of security and privacy. Much of her work has focused on designing techniques to detect and defend against adversaries who manipulate Internet traffic in order to block, monitor, or tamper with users' online activities. Her PhD dissertation presented a significant new technique to measure Internet filtering from thousands of Internet vantage points. She is a recipient of the 2016 Applied Networking Research Prize from the Internet Research Task Force for her paper entitled "Examining How the Great Firewall Discovers Hidden Circumvention Servers." Roya joins EECS from Princeton University, where she was a postdoctoral researcher.

NICOLE HAMILTON
Lecturer
MS, Electrical Engineering, 1973
Stanford University

Nicole has over 40 years' experience in software, including 30 years as an entrepreneur. She is the sole author of the Hamilton C shell, and she was the ninth member of the team at Microsoft that created the Bing search engine, for which she wrote the query language and ranker for its first release. She is a life senior member of the IEEE, and has 10 issued patents and numerous publications including a paper on search engine ranking that received a 10-year "test of time" award at the 2015 International Conference on Machine Learning. Today, Nicole approaches her teaching as an entrepreneur, with an emphasis on innovating to enable all of her students to succeed. Nicole joins EECS from the University of Washington Bothell, where she has been a lecturer in electrical engineering.

EMILY GRAETZ
Lecturer
MSE, Computer Science and Engineering, 2016 and MA, Mathematics, 2017
University of Michigan

Emily has taught EECS students since Fall 2013, first as a Graduate Student Instructor and more recently as an Intermittent Lecturer in EECS 203. As a GSI, she was selected for a Yahoo! Teaching Award in recognition of the high ratings she received from her students in EECS 280 and EECS 475. She is a passionate lifelong educator, having taught as a K-12 tutor and teacher in the past.

WESTLEY WEIMER
Professor
PhD, Computer Science, 2005
University of California, Berkeley

Westley's primary research interest is advancing software quality through both static and dynamic programming language approaches. He is particularly concerned with automatic or minimally-guided techniques that can scale and be applied easily to large, existing programs. He also works to help programmers address defects, understand programs, and program correctly. His research spans automated program repair, formal verification, program improvement, human studies, and language feature design. Westley joins EECS from the University of Virginia, where he was an associate professor. His work has led to over 8,400 citations, eight distinguished paper awards, four multi-conference research awards, and one ten-year most influential paper award.

{1948} CLAUDE SHANNON

Claude Shannon graduated from Michigan in 1936 with degrees in electrical engineering and engineering math. His landmark 1948 paper, "A Mathematical Theory of Communication," earned him the title, Father of Information Theory. Shannon also theorized the binary code of zeros and ones that makes all computing possible. His work was world changing, impacting the future of communications, data compression, statistics, natural language processing, cryptography, neurobiology, quantum computing, linguistics, and more.

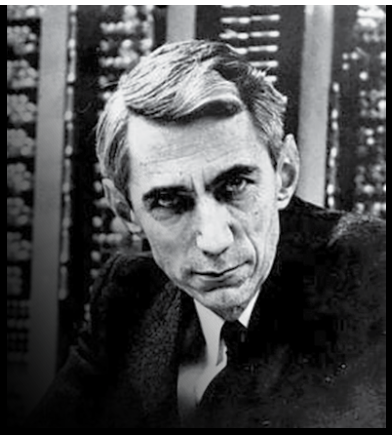


Photo courtesy Bentley Historical Library

NSF CAREER and Young Investigator Awards

REETUPARNA DAS
NSF CAREER Award, 2017

Project Title: *In-Situ Compute Memories for Accelerating Data Parallel Applications*

Prof. Das will design specialized data-centric computing systems that dramatically reduce the amount of time and energy it takes to move data from storage to compute units. This research will create in-situ compute memories, which repurpose the elements used in these storage structures and transform them into active computational units.

PARAG DEOTARE
AFOSR Young Investigator Award, 2017

Project Title: *Nanoscale Exciton-Mechanical Systems (NEXMS)*

Prof. Deotare is investigating the interactions between exciton and mechanics, which will lead to a better understanding of exciton dynamics. This work will deepen our understanding of the underlying physics of exciton-mechanics interactions and help engineer novel devices for energy harvesting and up-conversion.

EMILY MOWER PROVOST
NSF CAREER Award, 2017

Project Title: *Automatic Speech-Based Longitudinal Emotion and Mood Recognition for Mental Health Monitoring and Treatment*

Prof. Mower Provost will investigate new approaches in speech-based mood monitoring by taking advantage of the link between speech, emotion, and mood. The approach includes processing data with short-term variation, estimating mid-term variation, and then using patterns in emotion to recognize long-term variation.

NECMIYE OZAY
NASA Early Career Faculty Award, 2016

Project Title: *Run-Time Anomaly Detection and Mitigation in Information-Rich Cyber-Physical Systems*

Prof. Ozay will develop the scientific foundation and associated algorithmic tools for synthesis of decentralized passive and active monitors for sensor-rich networked cyber-physical systems from heterogeneous sensory data. Her research will be designed to assist in future missions in space, while being applicable to a wide range of cyber-physical systems.

BECKY PETERSON
NSF CAREER Award, 2017

Project Title: *Band Engineering in Amorphous Semiconductors*

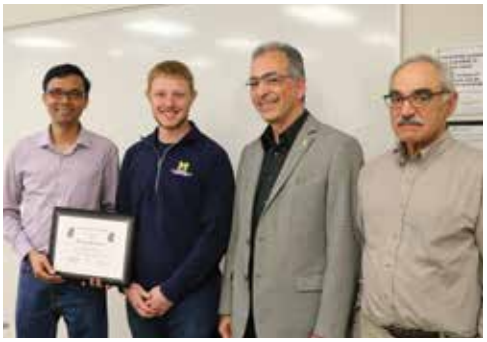
Prof. Peterson will develop new alloys of amorphous oxide semiconductors with precisely tuned semiconductor energy band structures, in order to enable new categories of electronic and opto-electronic devices.

HKN

PROFESSORS OF THE YEAR 2017

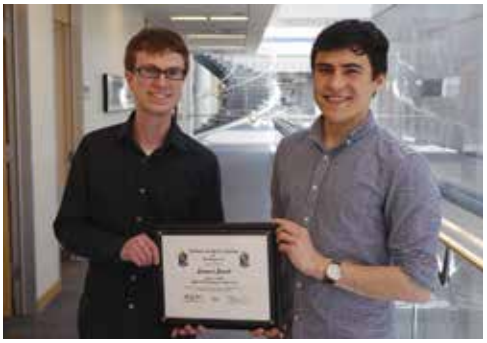
Each year, the U-M chapter of Eta Kappa Nu, the national honor society for electrical and computer engineers, selects two faculty for recognition, one from each division of EECS. The recipients are selected based on a vote by the students.

PARAG DEOTARE (ECE)



Parag Deotare, Eli Sherman (HKN Vice President), Khalil Najafi (ECE Chair), Dave Neuhoff (ECE Sr. Associate Chair)

JAMES JUETT (CSE)



James Juett, Matt Solarz (HKN President)

EECS Outstanding Achievement Awards

Khalil Najafi (ECE Chair), Marcus Darden, Peter Chen (Interim CSE Chair), David Paoletti

MARCUS DARDEN received the award for tireless work in improving the quality of instruction, and for helping students to develop a commitment to lifelong learning.

Peter Chen (Interim CSE Chair), Herbert Winful, Almantas Galvanauskas, Khalil Najafi (ECE Chair)

ALMANTAS GALVANAUSKAS received the award for pioneering achievements in fiber laser technology, including the invention and commercialization of the chirally-coupled-core fiber and achievement of record-breaking pulse energies and peak powers from fiber lasers.

Khalil Najafi (ECE Chair), Peter Chen (Interim CSE Chair), Atul Prakash, H.V. Jagadish

ATUL PRAKASH received the award for innovative research in the design of secure systems and for leadership in the development of an undergraduate program in Data Science.

EUISIK YOON received the award for outstanding contributions to microelectromechanical systems (MEMS), and innovative research and leadership in biomedical microsystems and neurotechnology.

EECS Awards

Morris Wellman Faculty Development Professorship

BARZAN MOZAFARI
Granted to junior CSE faculty members in recognition of outstanding contributions to teaching and research.

College of Engineering Awards

ALFRED HERO
John H. Holland Distinguished University Professor and R. Jamison and Betty Williams Professor of Engineering

Stephen S. Attwood Award, "for extraordinary achievement in teaching, research, service, and other activities."

HEATH HOFMANN
Jon R. and Beverly S. Holt Award for Excellence in Teaching

MINGYAN LIU
Monroe-Brown Foundation Service Excellence Award

WEI LU
David E. Liddle Research Excellence Award

Z. MORLEY MAO
George J. Huebner, Jr. Research Excellence Award

DAVID PAOLETTI
Thomas M. Sawyer, Jr. Teaching Award

Patrick C. Fischer Development Professorship in Theoretical Computer Science

CHRIS PEIKERT
Prof. Peikert is the inaugural recipient of this professorship. Charlotte Fischer, Emerita Professor of Computer Science at Vanderbilt University, endowed this professorship in her late husband's name. An alumnus of Michigan, Patrick C. Fischer was an expert in computational complexity, interactive database systems, and informational systems for education institutions whose work in theoretical CS helped make Internet searches possible.

University Awards

VALERIA BERTACCO
U-M Arthur F. Thurnau Professorship

Granted to tenured faculty with a sustained record of excellence in undergraduate education.

MARY LOU DORF
U-M Collegiate Lecturer
Provost's Teaching Innovation Prize

TONY ENGLAND, Dean, College of Engineering and Computer Science, U-M Dearborn

Susan B. Anthony Campus Award from U-M, Dearborn

MICHAEL FLYNN
Faculty Recognition Award

KEVIN FU
Regents' Award for Distinguished Public Service

National and Professional Honors, Awards, and Activities

EHSAN AFSHARI is a Distinguished Lecturer for the IEEE Solid-State Circuits Society through 2017. He was also selected as one of 50 Most Distinguished Alumni of Sharif University.

TODD AUSTIN was named IEEE Fellow, Class of 2017, "for contributions to simulation techniques and resilient system design in computer architecture." He gave the 2016 Distinguished Bradley Lecture at Virginia Tech University.

SATINDER SINGH BAVEJA served as Associate Editor in Chief for the *Journal of Artificial Intelligence Research* beginning in 2016. He served as Program Committee Co-Chair for the 2017 Association for the Advancement of Artificial Intelligence Conference and Conference Organizer for the 2017 Reinforcement Learning and Decision Making Conference.

DMITRY BERENSON received a 2016 IEEE Robotics & Automation Society (RAS) Early Career Award "For contributions to the theory and implementation of robot motion planning and manipulation."

VALERIA BERTACCO, Arthur F. Thurnau Professor, has been named an IEEE Fellow, Class of 2017, "for contributions to computer-aided verification and reliable system design." She served as Program Committee Chair, 2017 Design Automation Conference.

PALLAB BHATTACHARYA, Charles M. Vest Distinguished University Professor and James R. Mellor Professor of Engineering, was named Fellow of the National Academy of Inventors (NAI).

PETER M. CHEN, Arthur F. Thurnau Professor, served as Program Committee Chair, 2017 Symposium on Operating Systems Principles.

LYNN CONWAY, Professor Emerita, was elected Fellow of the American Association for the Advancement of Science for groundbreaking and fundamental contributions to Very Large Scale Integration (VLSI) design and production of integrated circuits.

National and Professional Honors, Awards, and Activities

JASON CORSO received a 2016 ICRA CEB Best Associate Editor Award from the IEEE International Conference on Robotics and Automation (ICRA 2016).

JIA DENG won the 2016 PAMI Everingham Prize for his work in developing ImageNet, a large-scale labeled image database that has powered many recent advances in computer vision.

EDMUND DURFEE served as Program Co-Chair, 2017 International Conference on Autonomous Agents and MultiAgent Systems.

CINDY FINELLI was among 48 faculty members across the country invited to attend the 2016 National Academy of Engineering (NAE) Frontiers of Engineering Education Symposium. This symposium is an opportunity for engineering educators to exchange ideas and discuss innovative classroom techniques.

Stephen Forrest receiving the IEEE Jun-ichi Nishizawa Medal

STEPHEN FORREST, Peter A. Franken Distinguished University Professor and Paul G. Goebel Professor of Engineering, received the 2017 IEEE Jun-ichi Nishizawa Medal along with Ching W. Tang and Mark Thompson, "For their pioneering work on organic devices, leading to organic light-emitting diode displays."

Prof. Forrest also delivered the Peter A. Franken Distinguished University Professor Lecture, "Organic Light Emitting Devices (OLEDs): The Coming Revolution in Displays and Lighting" (available on Youtube).

JASON FLINN has been elected a Fellow of the Association for Computing Machinery (ACM) "for contributions to mobile computing and reliable distributed systems."

KEVIN FU gave keynote addresses at the 2016 Analog Devices IoT Retreat and at the 2016 ACM Great Lakes Symposium on VLSI.

ANTHONY GRBIC was a Plenary Speaker at the International Congress on Advanced Electromagnetic Materials in Microwaves and Optics (Metamaterials 2016). His talk was titled "Electromagnetic Metasurfaces: Science and Applications."

J. ALEX HALDERMAN gave keynote addresses at the 2016 Information Security Conference and at the 2016 Merit Security Summit.

AL HERO, John H. Holland Distinguished University Professor and R. Jamison and Betty Williams Professor of Engineering, was the Commencement Speaker at Boston University in 2016. In addition, he gave a keynote address at the following conferences: 2016 IEEE Global Conference on Signal and Image Processing; 2016 Graph Exploitation Workshop; 2016 Future Directions in Compressive Sensing and Sensing-Processing Integration Workshop; 2016 Symposium on Frontiers of Big Data; and the 2016 MIT Lincoln Laboratory Workshop on Graph Exploitation (GraphEx). And finally, he gave the plenary address at the following conferences: 2016 Workshop on Data Driven Approach to Networks and Language; 2016 Inaugural Workshop of Shenzhen Institute of Big Data.

IAN HISKENS, Vennema Professor of Engineering, chaired the IEEE PES technical committee "Benchmark Systems for Stability Controls Task Force," which received the IEEE PES Technical Committee Working Group Recognition Award. He presented the keynote address at the IEEE PES Innovative Smart Grid Technologies (ISGT) – Asia Conference in Australia.

National and Professional Honors, Awards, and Activities

MOHAMMED ISLAM received a 2016 Outstanding Achievement Award from American Association of Bangladeshi Engineers and Architects.

CHAD JENKINS served as Editor-in-Chief for the *ACM Transactions on Human-Robot Interaction* journal beginning in 2016.

BENJAMIN KUIPERS gave keynote addresses at the 2017 SOAR Workshop, the 2016 RSS Workshop on Social Trust in Autonomous Robots, Spatial Cognition 2016, and the 2016 ICDL-Epirob Workshop on Autonomous Perception: Sensorimotor Contingencies and Predictive Processing to Developmental Robotics. He gave the plenary talk at RoboPhilosophy 2016.

MARK KUSHNER, George I. Haddad Professor of EECS, received the 2017 Plasma Chemistry Award (PCA) for his lifetime of achievements in the field of the Plasma Chemistry.

JOHN LAIRD, John L. Tishman Professor of Engineering, gave keynote addresses at the 2016 Joint Multi-Conference on Human-Level Artificial Intelligence, the 2016 Cognition for Human Performance and Autonomous Systems Workshop, the 2016 The Future of AI Symposium, the 2016 NSF Intelligent Cognitive Assistant Workshop, the 2016 Robotics Systems and Science Workshop on Representations for Robotics, the 2016 Robotics Systems and Science First International Workshop on Robot Planning and Learning, and the 2016 Workshop on the Integration of Control Theory, Formal Methods, Learning and Human Factors for Autonomous Systems. He served as Conference General Chair for the 2016 and 2017 SOAR Workshops and for the 2017 Ernst Strungmann Forum on Interactive Task Learning.

HARSHA MADHYASTHA has been awarded a 2017 Google Faculty Research Award for his work in enabling the deployment of low-latency web services in the cloud, and a Facebook Faculty Award for his work in distributed systems and computer networking.

MINGYAN LIU received the 2016 "Crossing the Valley of Death" PI Excellence Award from the Department of Homeland Security, Cyber Security Division, for her successful startup company, QuadMetrics.

SEMYON MEERKOV was unanimously elected as a Foreign Member of the Russian Academy of Sciences for his contributions to Systems Science and Automation. He was also the Plenary Speaker at the 2016 International Conference on Stability and Oscillations, Russia.

ZETIAN MI was elected Fellow of the International Society for Optics and Photonics (SPIE) "for contributions to the development of high performance III-nitride nanowire photonic devices, including electrically injected deep UV lasers, full color nanowire LEDs, and high efficiency artificial photosynthesis."

Prof. Mi is also Conference Co-Chair of the 11th International Symposium on Semiconductor Light Emitting Devices (ISSLED 2017), October 12, 2017 in Banff, Canada.

EMILY MOWER PROVOST served as Program Committee Chair, 2017 Affective Computing and Intelligent Interaction. She gave the keynote address at the Emotion in the Wild Workshop, International Conference on Multimedia Interaction.

TREVOR MUDGE, Bredt Family Professor of Engineering, has been elected a Fellow of the Association for Computing Machinery (ACM) "for contributions to power aware computer architecture."

KHALIL NAJAFI, Peter and Evelyn Fuss Chair of Electrical and Computer Engineering and Schlumberger Professor of Engineering, served as President of the Electrical and Computer Engineering Department Heads Association during the past year. He now serves as Past President.

National and Professional Honors, Awards, and Activities

TED NORRIS, Gérard A. Mourou Professor of EECS and Director of the Center for Photonic and Multiscale Nanomaterials (C-PHOM), is co-organizer of the 2017 Fundamental Optical Processes in Semiconductors (FOPS), held August 27-September 1, 2017 in Stevenson, WA.

BECKY PETERSON received the 2018 U-M Henry Russel Award, which is the University's highest honor for faculty at the early to mid-career stages of their career.

SETH PETTIE gave the keynote address at China Theory Week 2016.

JAMIE PHILLIPS served as Conference Chair for the 58th Electronic Materials Conference.

KAMAL SARABANDI, Rufus S. Teesdale Professor of Engineering, was elected Fellow of the American Association for the Advancement of Science (AAAS) "For broad contributions to the field of applied electromagnetics, to engineering education, and to sustained economic growth." He also received a Distinguished Alumni Award from Sharif University of Technology in 2016, and gave the keynote address at two conferences: the 2017 IEEE Canadian Conference on Electrical and Computer Engineering, and the 2017 International Workshop on Remote Sensing with Intelligent Processing. His talk, Remote Sensing Science and Technology in Support of Exploration and Safe Utilization of Energy Resources, presented December 9, 2016 as part of the IEEE Geoscience and Remote Sensing Distinguished Lecturer Program, is available on Youtube.

THOMAS B.A. SENIOR was named a Fellow of the International Union of Radio Science.

YAOYUN SHI gave the keynote address at the 2016 Asian Quantum Information Science Conference.

KANG G. SHIN, Kevin and Nancy O'Connor Professor of Computer Science, gave the keynote speech at the 2016 IEEE International Conference on Mobile Ad hoc and Sensor Systems.

ELLIOT SOLOWAY, Arthur F. Thurnau Professor, served as Editor in Chief, *Smart Learning Environments Springer Open Journal* beginning in 2016. He gave keynote addresses at the 2016 Computer Assisted Language Instruction Consortium Conference and at the 2016 Mobile Summit.

DUNCAN STEEL received an Alfred P. Sloan Foundation award for work on advancing minority students in STEM.

DENNIS SYLVESTER was recognized for his distinguished talk at at the Microsystems Strategic Alliance of Quebec (ReSMIQ) annual symposium. He appeared there as a Distinguished Lecturer of the IEEE Solid-State Circuits Society.

LINGJIA TANG received a Facebook Faculty Award for her work in computer architecture. She served as Program Committee Chair, 2017 International Symposium on Code Generation and Optimization.

National and Professional Honors, Awards, and Activities

MICHAEL WELLMAN, Lynn A. Conway Collegiate Professor of Computer Science and Engineering, served as Program Committee Co-Chair, 2016 AAAI Conference on Artificial Intelligence.

JENNA WIENS served as Conference General Chair, 2016 Machine Learning for Healthcare.

THOMAS F. WENISCH was recognized in the International Conference on Architectural Support for Programming Languages and Operating Systems ASPLOS Hall of Fame, 2017. He served as Program Committee Co-Chair, 2017 International Symposium on Low Power Electronic Design and as Program Committee Chair, 2017 IEEE MICRO Top Picks.

EUISIK YOON, Director of the International Program for the Advancement of Neurotechnology, organized the 2017 International Conference for Advanced Neurotechnology, held June 29, 2017 in Freiburg, Germany.

2017 ISCA Influential Paper Award

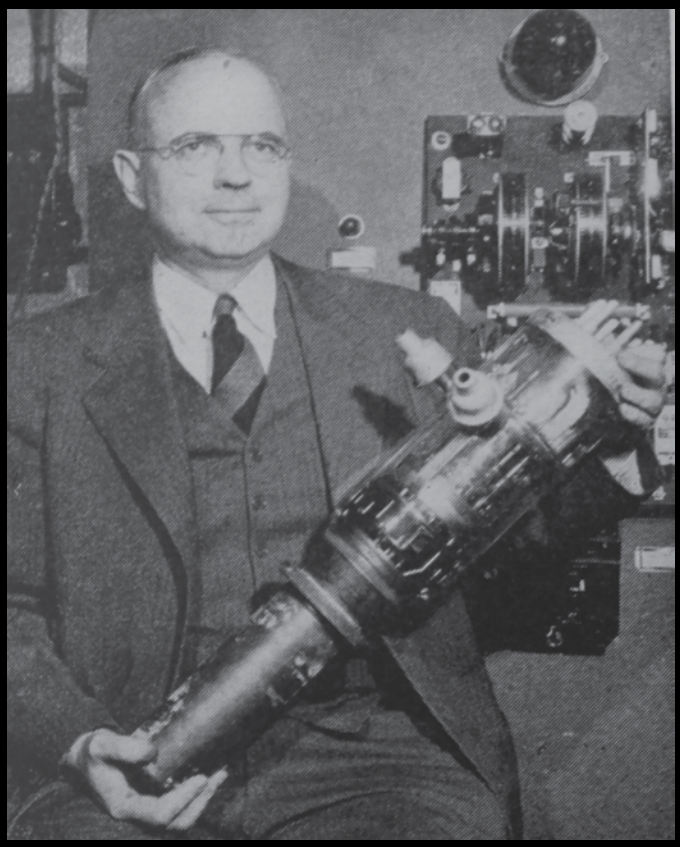
Prof. David Blaauw, Bredt Family Professor of Engineering Trevor Mudge, and EECS alumni Krisztián Flautner, Nam Sung Kim, and Steve Martin received the 2017 ACM SIGARCH and IEEE-CS TCCA (Technical Committee on Computer Architecture) ISCA (International Symposium on Computer Architecture) Influential Paper Award, which recognizes a paper published 15 years ago in ISCA Proceedings that has had the most impact on the field during the intervening years. The paper, “Drowsy Caches: Simple Techniques for Reducing Leakage Power,” was written in 2002.

DAVID BLAAUW

TREVOR MUDGE

{1926–1965} WILLIAM GOULD DOW

William Gould Dow (MS EE 1929) was one of the department’s most influential leaders. His forty years at Michigan began with graduate study in 1926 and ended as department chair in 1965. He was largely or solely responsible for creating and organizing at least 13 laboratories and research units throughout the College of Engineering, and helped bring sponsored research to the Midwest. Dow was a charter member of the Rocket and Satellite Research Panel, a group of distinguished scientists and engineers who guided the nation’s space program through its infancy. He wrote the classic textbook on electronics, *Fundamentals of Engineering Electronics*, in 1937, which remained a standard for many year. During WWII, he supervised the development of a 125-ton radar jamming device, called a Tuba (pictured right), used in jamming German and Japanese radar equipment. These radar-jamming countermeasures were credited with saving the lives of many Allied pilots.



Faculty Speak Out on AI

It seems that machines are starting to not only outproduce us, they're also starting to outthink us. Whether or not the idea of a malevolent superintelligence is extreme, it's clear that we don't yet know where AI will lead us, or how quickly.

Markov Explains How to Avoid the AI Apocalypse

Prof. Igor Markov gave a talk at the 2017 AI Conference, where he explained how to avoid a potential upcoming AI apocalypse. According to Markov, he has been thinking of how to prevent an AI takeover for more than a year. He now believes the most important way for humans to prevent the rise of malicious AI is to put in a series of physical world restraints. Failing that, he also suggested that a strategy would be to domesticate AI in the same way Homo Sapiens turned wolves into their protectors and friends.

Kuipers Warns of Side Effects From Unconstrained AI

In a panel discussion at the Future of Life Institute, Prof. Benjamin Kuipers pointed out that although humans typically program AI-powered robots to accomplish a particular goal, these robots will typically make additional decisions on their own to reach that goal.

It's these smaller, independently made incremental decisions that can cause trouble because human programmers may fail to take all of a robot's possible choices into account, according to Kuipers. "What we're seeing here are robots pursuing human-generated goals in unconstrained ways."

Kuipers has also called for ethical principles for robots, and has suggested that intelligent robots should engage in a feedback-driven learning process, like children do, in order to learn how to behave according to the standards of our society.

Wellman Doomsday Scenario: Intelligent Stock Market Trading Run Amok

Michael Wellman, the Lynn A. Conway Collegiate Professor of Computer Science and Engineering, served as a panelist in a workshop hosted by Arizona State University to anticipate and prevent possible adverse outcomes of artificial intelligence.

Participants at the Envisioning and Addressing Adverse AI Outcomes workshop devised worst-case scenarios and conference organizers selected several to focus on. Prof. Wellman proposed a scenario of malicious stock market manipulation, which was chosen for discussion. Intelligent high-speed trading has the potential to destabilize markets, says Wellman, who proposes the solution of introducing time constraints on trades. But Wellman also notes that automatically generated social media posts and other sidewise activities can create uncertainty that will influence markets.

{1995} ACADEMIC JOURNAL DATABASE LAUNCHED

Early work led by Daniel E. Atkins at Michigan in the 1980s and 1990s in the area of digital collaboration led to the release in 1995 of *JSTOR*, the first academic journal database. Today, *JSTOR* hosts more than 10 million journal articles and 45,000 academic books.

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JSTOR

Security Experts Testify About Computer Security and Public Policy

J. Alex Halderman Testifies at Senate Hearing on Election Security

Prof. J. Alex Halderman testified in front of the Senate Intelligence Committee on June 21, 2017 as a part of the Russian Interference in the U.S. Election investigation. His remarks focused vulnerabilities in the U.S. voting system and a policy agenda for securing the system against the threat of hacking.

Prof. Halderman emphasized that “our highly computerized election infrastructure is vulnerable to sabotage, and to cyberattacks that could change votes.”

Prof. Halderman and his colleagues say the U.S. can safeguard elections through upgrading and replacing obsolete and vulnerable voting machines, consistently and routinely checking that election results are accurate, and applying cybersecurity best practices to the design of voting equipment and the management of elections.

Kevin Fu Testifies to Congress Regarding IoT Security

Prof. Kevin Fu testified in front of the House Energy and Commerce Committee on November 16, 2016 regarding the need for a national mandate for security guidelines for Internet of Things (IoT) devices. Fu pointed to the IoT-powered Dyn attack and warned of gaping holes in connected devices, from planes and cars to appliances and medical devices. Regarding a mandate, Fu said that companies don’t have an incentive to prioritize security and “I fear for the day every hospital system is shut down.”

Prof. Fu has made sustained efforts to inform policymakers and Congress about computer and medical device security. He has testified regularly in U.S. House and Senate hearings on matters of cybersecurity and helped to bring about an improved set of FDA regulations for medical device security after nine years of testifying on that subject. For these efforts, he has been recognized with the 2017 Regent’s Award for Distinguished Public Service.

{1987} MERIT, NSFNET, AND THE INTERNET

The Michigan Educational Research Information Triad (MERIT) was created in 1966 to connect the mainframe computers of the University of Michigan and ultimately seven other universities. U-M alumnus and former faculty member Bertram Herzog served as its first director, and Eric Aupperle (BSE EE and Math 1957; MSE Nuclear Eng 1958; PHD Instrumentation Eng 1964) was its first employee and served as president from 1988-2001. In 1987, MERIT was selected as the lead organization to upgrade NSFNET, which networked five supercomputing centers. Merit dramatically improved the new network’s speed and reliability while accommodating rapid growth, and by 1991, its network service was covering the world – for free.

Valeria Bertacco Appointed Associate Dean at Rackham Graduate School

Thurnau Prof. Valeria Bertacco has been appointed Associate Dean for Academic Programs and Initiatives at Rackham Graduate School.

In this capacity, she serves as the primary liaison between the Rackham School and academic units in the physical sciences and engineering. Prof. Bertacco works closely with these programs to assess and promote best practices in graduate education and to achieve student success, to serve as a contact for the Rackham School on campus and nationally, and to promote and support cross-unit partnerships and interdisciplinary efforts and develop new initiatives and programs, including efforts in the areas of diversity, climate and professional development.

Jessy Grizzle Appointed Director of Michigan Robotics

Jessy Grizzle, Elmer G. Gilbert Distinguished University Professor and Jerry W. and Carol L. Levin Professor of Engineering, will serve as U-M's first Director of Robotics. In this role, he is overseeing planning and development of the university's newly-announced Ford Motor Company Robotics Building.

"My own experience helps me understand the freedom and community support that new faculty need to follow bold agendas that no one else believes in," said Grizzle, "and part of my job is to give it to them."

Wei Lu Appointed Director of the Lurie Nanofabrication Facility

Prof. Wei Lu has been named the Director of the Lurie Nanofabrication Facility (LNF), taking over from Prof. Euisik Yoon. This public world-class facility has over 13,500 sq. ft. of state-of-the-art cleanroom space that provides researchers the ability to fabricate a sweeping array of solid-state materials, devices, circuits, and microsystems using silicon, compound semiconductors, organic, and other emerging materials.

As the single largest user of the facility, Prof. Lu conducts research in emerging electrical devices such as resistive random-access memory (RRAM), neuromorphic circuits, and nanowire transistors. His research has resulted in the successful startup company, Crossbar, Inc., which is now delivering commercial memory products to customers.

{1984} DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE ESTABLISHED

Photo courtesy Bentley Historical Library

The EECS Department was formed by bringing together the Electrical and Computer Engineering Department, the Computer, Information, and Control Engineering (CICE) graduate program, and from LSA, the Computer and Communication Sciences (CCS) Department. Located on Central Campus until its move to North Campus in 1986, the new department offered undergraduate degrees in EE, CE, and CS as well as Masters and PhD degrees in EE, EE:Systems, and CSE.

Retirements

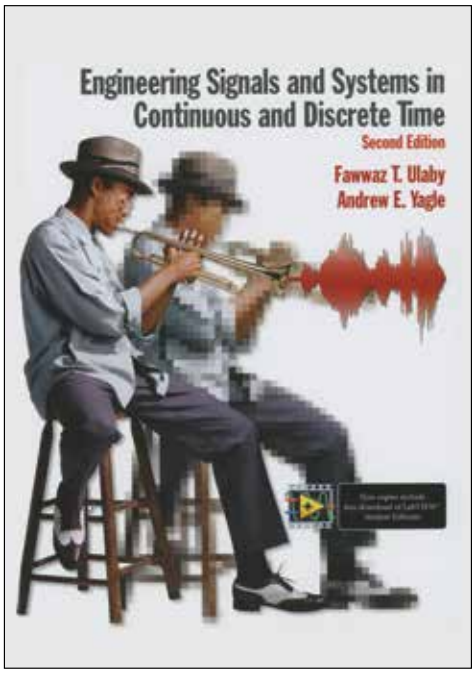
ANDY YAGLE

Prof. Andy Yagle retired May 31, 2017 after 32 years at the University of Michigan. His career was distinguished by his dedication to teaching as well as contributions to research in the area of signal and image processing.

A nearly lifelong Ann Arbor resident, Andy is as Maize and Blue as they come. He was born in the university hospital and raised by Michigan alumni parents. His father was a Michigan engineering faculty member and his mother was a nurse at U-M Hospital. Yagle holds two U-M bachelor's degrees in engineering science and electrical engineering, 1977 and 1978, respectively.

Andy's research in signal processing focused on problems in inverse scattering, iterative algorithms in medical imaging, fast algorithms for digital signal processing, sparse imaging, and phase retrieval. His theoretical research was applicable to a wide range of fields, including geophysics, acoustics, cardiology, and magnetic resonance imaging (MRI).

His research earned him an NSF Presidential Young Investigator Award and an Office of Naval Research Young Investigator Award. He later received the College of Engineering (CoE) Class of 1938 Award for outstanding contributions to research as well as teaching.



Andy received a number of awards specifically focused on teaching, including a CoE Teaching Excellence Award and an Eta Kappa Nu Professor of the Year award, which is voted on by the students themselves. It is no surprise that Andy consistently received extremely high scores for his undergraduate teaching.

In his role as Chief Program Advisor for the EE program, he provided valuable input on the CoE Curriculum Committee, the EE Curriculum Committee, and the CoE Admissions Committee, and served as ABET coordinator for the EE program for two different reviews. His lifelong dedication to the education of students was recognized by the College of Engineering Service Excellence Award in 2013.

In recent years, he turned his attention to co-authoring the textbook, *Engineering Signals and Systems*, with Prof. Fawwaz Ulaby. Although it has only been in print since 2013, it has already been adopted by nearly 40 universities, including Cornell, Illinois, and Texas. The book is in its second edition.

Retirement doesn't signal the end of Andy's efforts. His textbook with Ulaby "never stops" – as he plans to continue maintaining a solutions and examples companion website for the book. In addition, he and Ulaby plan to write a second textbook on image processing.

VAL LIEPA

Dr. Valdis V. Liepa, research scientist in ECE, retired January 31, 2017 after more than 50 years as either a student or faculty member in the department. Dr. Liepa earned his BSE, MS, and PhD degrees in EE (1958, 1959, and 1966, respectively), and joined the Radiation Laboratory in 1968.

Throughout his career, Dr. Liepa worked on problems in applied electromagnetics. His interests were in the areas of antennas, development and use of sensors for radio-frequency interference, electromagnetic interference measurements, stealth basics, radar-cross-section measurements and measurement systems, and measurements of surface currents and charges induced on the exterior and interior of various shapes, including those of scale model aircraft and missiles. Throughout his career, he advised municipalities and citizen groups in matters of electromagnetic radiation from devices such as cellular towers and traffic and weather radar systems.

Dr. Liepa also taught classes occasionally, including special project and design courses involving radio frequency, microwaves, and optics, and served as a doctoral committee chair for several students. In 2006, he co-authored the book *Applied Electromagnetics and Electromagnetic Compatibility* with Dipak Sengupta, a former research scientist in ECE.

Austra Liepa, Prof. Emeritus George Haddad, Val Liepa

Val Liepa in the mid 1980's

MARY LOU DORF

Collegiate Lecturer Dr. Mary Lou Dorf has retired after 15 years in the EECS Department. In her time here, Dr. Dorf worked tirelessly to open the doors of computer science to everyone.

In 2012, she led a campaign aimed at generating awareness of and interest in the computer science undergraduate major and minor programs that are available to students in the College of LSA.

She recently transformed EECS 183, Elementary Programming Concepts, the introductory course in CS for LSA students, into an interactive and inclusive experience that culminates in a substantial final programming project with an event to showcase the finished projects.

Dr. Dorf and the staff from EECS 183 in Winter 2017

These initiatives have been instrumental in creating a sense of excitement, empowerment, and opportunity amongst LSA students about CS, and the number of LSA students declaring CS as a major has since soared by 6X.

Dr. Dorf has a particular interest in removing barriers for women interested in the field of computer science, and has spearheaded a number of programs aimed at improving the climate for all students and increasing female student retention. Amongst her teaching recognitions have been her naming as a Collegiate Lecturer and the Provost's Teaching Innovation Prize for her use of innovation to improve student learning.

Student NEWS

Silver Medal Finish for Olympic Rower

EECS undergrad and Ann Arbor native Zach Burns brought home a silver medal from the Rio de Janeiro Summer Olympics in September as part of the U.S. Paralympic Rowing Team. This was Zach's third year with the team, finally getting to take on the Olympic games after two years traveling to the World Championships. Zach raced in a boat with four others from around the country in the Legs, Trunk and Arms Four with Coxswain event. They finished second behind Great Britain, with a mere 2-second finish time margin.

> "I'm taking a breather for a moment, but…it would definitely be cool to go to Tokyo in 2020."
>
> — Zach Burns

Zach Burns, center, pictured with his crewmates; the crew won silver in the LTA Mixed Coxed Four at the Rio 2016 Paralympic Games.

UM::Autonomy: Design Changes and Challenges

The UM::Autonomy team brought their latest autonomous boat, called Thurman, to participate in the Association for Unmanned Vehicle Systems International Foundation Roboboat competition. The boat, which is completely designed and programmed by the students, must complete a wide range of challenges that are designed to expose students to the many difficulties of autonomous operation on the water.

This year, they simplified the code that ran the boat and changed their design to a more stable model. They also added a business team unit. Though the team didn't make it to the finals, they received an award for the best team introduction video and journal paper, and placed second in the design presentation session.

L-R: EECS students on the team: Rebecca Sorgenfrei (President), Anthony Uytingco (Electrical Team Lead), Elliot Mueller (Vice President), Hanna Kawoosa (Electrical Team Lead), Thomas Huang (AI Team Lead), Benny Johnson (AI Member), Alex Skillin (AI Member)

UMIGV: New Student Team Builds Autonomous Vehicles

The University of Michigan Intelligent Ground Vehicle (UMIGV) team finished its first year primarily organizing and fundraising, and has been building a prototype autonomous robot platform during the summer.

"I attended the National Academy of Engineering symposium on autonomous vehicles and was just blown away by all the opportunities in this space," said EECS student Adarash Mishra, who co-founded UMIGV and led the team through its first year. "We wanted to build a product that could have real-world applications in a very tangible way."

The team aims to build a fully autonomous vehicle by June 2018 to compete in the IGVC competition. They demoed a prototype vehicle at the Ann Arbor Summer Fest, with several computer vision demos on screens, an active lidar unit with object recognition on screen, and the shell of the vehicle fully assembled.

STARX: New Student Exoskeleton Team Launches Prototype

The nearly-new student team STARX (STrength Augmenting Robotic eXoskeletons) just completed its second year of making practical powered exoskeletons that increase the effective strength of the user. Their newest load-bearing exoskeleton is called the Lexo. In its finished state, the Lexo will transfer a load of up to 100 lbs off of the user and into the ground. The Lexo is controlled by two hydraulic dampers attached across the knee joint, run by an Arduino in an attached backpack unit.

"Having the Lexo up and running is a dream come true for all of us at STARX," said EE student Own Winship, "and we can't wait to improve on it next year."

Currently, no collegiate competition exists for exoskeleton design. To fill this need, STARX is working to organize the first collegiate exoskeleton competition right here in Ann Arbor, to be called the Applied Collegiate Exoskeleton Competition (ACE). In doing so, the students hope to get more engineers working on exoskeleton research, which at the moment is very limited.

{1972} COMPUTERIZED COURSE REGISTRATION AT MICHIGAN

The concept of CRISP, or Computer Registration Involving Student Participation, began in CCS 673, taught by Bernard A. Galler. The class's concept for a computerized registration system was adopted as the official method for course registration at Michigan in 1975 and moved to a touchtone-based telephone system in 1994.

Photo courtesy Bentley Historical Library

MHybrid Builds the Most Innovative Car With the Best Propulsion

The Michigan Hybrid Racing (MHybrid) team took their latest creation to the Formula Hybrid Competition in May, and earned the FCA Innovation Award and General Motors Best Propulsion System Award. They placed 5th in the hybrid category.

This year's car was a major overhaul from their previous designs. The team designed, built, and implemented two in-hub motors, and used two independent battery packs on the vehicle to power each of them. This greatly increased the complexity of the electric vehicle powertrain, but allowed for better packaging, isolation, and access to battery packs. Also, the controls team developed a smart steering wheel, which allowed for less wiring and improved error checking, and added telemetry, which gave them a live view of the car while it was in operation.

The team was led in part by EECS students Madison Warsaw (EV Lead), Yeabsera Kebede (EV Controls Lead), and Colin Wagner (Business Lead).

Baja Racing Team First to Three-Peat National Championship

The U-M Baja Racing team earned first place in the national competition for the third year in a row. This makes them the first team to ever three-peat the championship, which involves competing in three races (in Gorman, CA, Pittsburg, KS, and Peoria, IL).

The Baja Racing team designs and manufactures a new off-road race vehicle every season. This year, the team drastically improved handling by making slight changes to the front suspension and completely redesigning the rear suspension. The competition reached new levels of drama in California, where the car was involved in a four-vehicle crash (no one was hurt). "We spent nearly two hours of the four hour endurance race off the track making repairs," said CS student Zechariah Schneider, Logistics Director for the team.

MASA: Hybrid Rocket Team Takes First Place at Inaugural Competition

The Michigan Aeronautical Science Association (MASA) won the first ever Spaceport America Cup, an intercollegiate rocket engineering competition, against over 110 teams from colleges and universities in eleven countries. They took first place in the hybrid propulsion 30,000 ft. launch category, and were voted overall winners by a panel of judges.

MASA is an interdisciplinary team that designs and fabricates sounding rockets, focusing on projects involving new hybrid propulsion technologies and composite structures. Their rocket, named Tortas 8 after a Mexican restaurant where the team eats after engine tests, was powered by a student-built hybrid rocket engine, called Gamma Centauri, that members have been developing for 3 years.

A lot of EECS work went into supporting the test, including sensor setup, data logging, and solenoid/valve control. The avionics team built a wireless control system for the flue filling procedure, allowing the rocket launch to be controlled from beyond the required 1,000 ft. distance. This was the team's first all-wireless launch system used at competition.

"The launch at competition was one of my favorite moments. It was the culmination of a massive effort over the course of the past year," said EE student Jacob Sigler, Chief Engineer for the team.

Mars Rover Makes Finals

The U-M Mars Rover Team brought a new remote astronaut assistant to the University Rover Challenge in the desert of southern Utah, and made it into the final 30 out of the initial 81 participants. The team made several design improvements over last year's model, including big upgrades to the soil sampling drill, a lighter and stronger robotic arm, and more carbon fiber to reduce the rover's mass. Four EECS students held leadership positions this year: Nathan Moos (Software subteam lead), Matthew Price (Integrated Controls subteam lead), Jason Whitfield (Communications subteam lead), and Tyler Dence (Information Systems Officer).

{1959} CREATION OF COMPUTING CENTER

Photo courtesy Bentley Historical Library

The Computing Center was established in the Rackham School of Graduate Studies to "provide consultation and computing service for teaching and research units of the University." The center installed a sequence of increasingly capable computers from its inception in 1959 through 1991 that were used for research and education.

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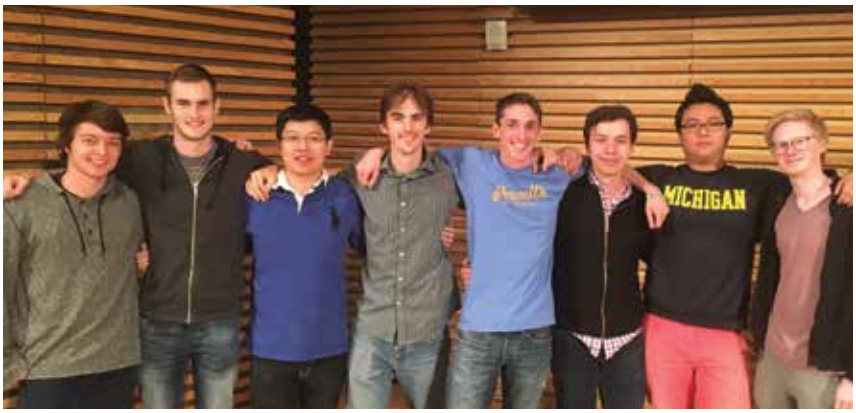


The Gwydion team: Daniel Burke, Gus (Mark) Schissler, Ruoxi Hao, Duncan Abbot, Paul (Robert) Stefanski, Robert Pakko, Elbert Han, James Mackin

A visitor play-tests one of Gwydion's early projects at the Gamers for Giving Convention, held in March 2016.

New Virtual Reality Student Startup Focuses on Child Therapy and 3D Gaming

EE senior Duncan Abbot and his virtual reality (VR) software startup Gwydion want to redefine how humans interact with technology, from tackling ambitious therapy in children's hospitals to helping materials scientists study 3D crystals. Propelled by a win at MHacks with a VR game, he and his co-founder, Paul Stefanski (BS English 2017), have partnered with Mott Children's Hospital. The team hopes this technology can help recovering kids feel less trapped in a hospital bed. The company is working on additional apps and video games, designed with the affordable Google Cardboard attachment in mind. The company's latest project, an app called Arthea, has been used by Prof. Joanna Millunchick (MSE) in classes to help students visualize crystal structures in 3D.

> "We're obsessed with new opportunities."
>
> — Duncan Abbot

Bringing Education to Disadvantaged Children in Ecuador

EECS undergrad Sam Tenka traveled to Ecuador with a team of four multidisciplinary engineers to work with youth who have not had the chance to attend school. As part of the Engineering Honors GO program, the team stayed in the city of Quito for two weeks to aid the Street Children Work project.

The team of engineers interacted with about 30 children each workday, teaching them a variety of basic life skills. Their lessons included hand washing, fine motor skills, and expressing their feelings through words and art. Many of the kids who participated in the program were accustomed to 12-hour shifts in local markets, lived in abusive households, and lacked opportunities to develop socially. When first presented with toys, Sam says, many would play solemnly and alone.

"It was isolation, abuse, and insecurity – not ignorance – out of which we worked to lead the children," says Sam.

One of Sam's proudest accomplishments from the trip was witnessing children in his group begin to open up and share their toys during playtime. "That behavior was unusual," he says. "That behavior was what we worked for."

Honors GO takes students abroad to perform service work in a variety of disadvantaged communities. Last year, the program sent a team to Peru.

"We were united by our excitement to learn about a new culture and have a positive impact," Sam says of his team. "The trip challenged us to apply our engineering mindset towards understanding the challenges of our host community."

Student's Instructional YouTube Channel Tops 6 Million Views

Daniel Dsouza's plan to share some knowledge ballooned into a huge following on YouTube. The ECE master's student produces short videos to help viewers succeed in career aptitude tests in India. He's been posting to his YouTube channel and website, called The Aptitude Academy, since 2013. In that time, Dsouza's lessons have gone viral and attracted 109,011 subscribers and over 6,300,000 views to date.

In India, aptitude tests are a required stepping stone to advanced knowledge and even a technical job. But as Dsouza found out, it takes specific knowledge that may or may not be covered in traditional settings.

"I found the test to be easy," said Dsouza. "But friends of mine that were much stronger technically had a hard time."

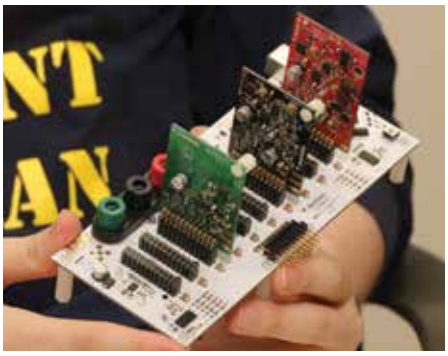
So he began to teach his friends, and then his friends' friends, one on one. As the circle of friends grew, his mother (Lira Dsouza, a teacher herself) encouraged him to share his know-how on YouTube. Though he'd never done anything like this before, he began to record instructional videos on his phone, and posted them on YouTube.

His early videos didn't draw a single view for nearly three months, but he plugged away through his first 10 videos. Eventually, with no advertising or promotional efforts, his videos started catching on – and they caught on big with audiences across India, into Pakistan, and even Thailand.

Dsouza began to post videos in response to user requests. He has now posted 63 lessons, with some drawing between 300 and 700 thousand views each. Every day his inbox and comments sections host a new batch of questions and requests.

At Michigan, Dsouza studies machine learning and natural language processing. In his first semester, he joined the Michigan Data Science Team in a challenge to address the water crisis in Flint. "Working in that competition, using numbers to make smart calls on how to take the next step, is what inspired me to study this area," says Dsouza.

Fred Buhler Builds Better Chips for "Aweslome" Applications



Fred Buhler holds a current model of his testing platform, with iterations dating back to his very first model laid out in front of him.

ECE PhD student Fred Buhler is working on more efficient chips for a broad range of applications, including machine learning, neural networks, security, and circuits testing. A part of Prof. Michael Flynn's lab since he was an undergrad, his work has resulted in high-profile published papers and a new company, Aweslome, LLC.

Aweslome has two business operations: consulting work to design and troubleshoot custom hardware platforms, and selling chips designed to help small fabless and research integrated circuit (IC) designers in testing and characterizing their own products. This product condensed the functionality of bulky lab equipment into a single chip, and showed superior noise characteristics under all testing conditions.

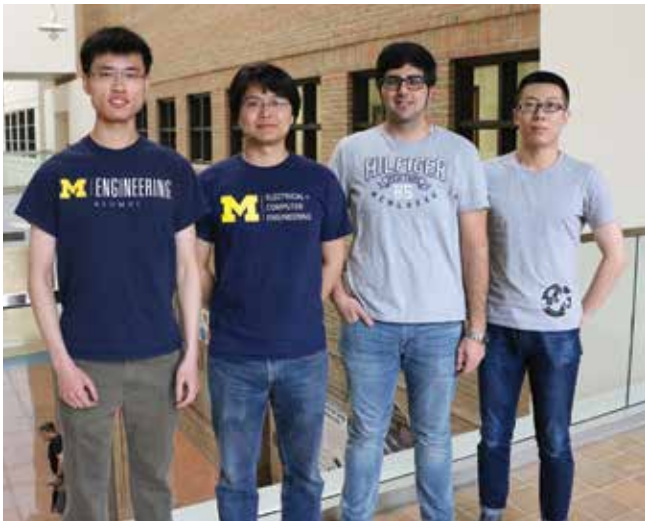
Buhler began work on this technology as an undergrad, when he spent his summer working in Prof. Michael Flynn's lab as part of the College of Engineering SURE program (Summer Undergraduate Research Experience). Buhler remained with Prof. Flynn's lab as he started his PhD studies. He now works on a variety of analog circuits, focusing in his first two years on using analog circuit blocks to do efficient computation for machine learning and neural network applications. Papers for Buhler's first two circuits were both published in IEEE Symposium on VLSI Circuits. Currently, Buhler is working on a new chip for nuclear security applications.

For the moment, Buhler is content to keep Aweslome small and manageable. With products that appeal to a niche of research startups and university labs, he doesn't expect it to grow into a giant – but he's already received interest from a number of labs around the country.

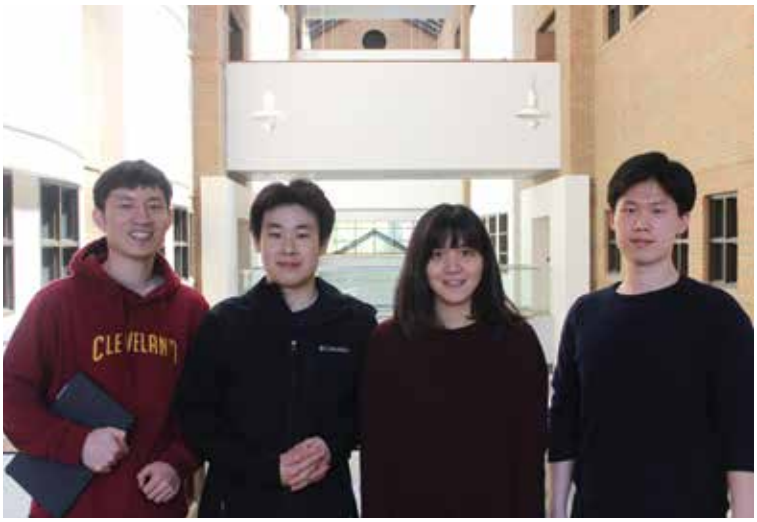
"I've had at least three visiting researchers tell me they'd be my first customer," Buhler says, referring to guest lecturers who have toured the lab. Additionally, he's already done consulting work for four companies around the state.

Prizes for Analog-Digital Converter Circuit Designs in EECS 511

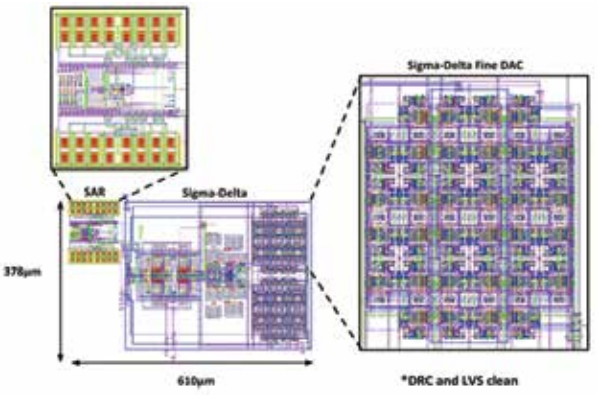
Students in the graduate level course, Integrated Analog/Digital Interface Circuits (EECS 511), taught by Prof. Michael Flynn, competed for cash prizes while presenting their final design projects thanks to the support of Analog Devices, Inc. The two winning teams designed ADCs for noise cancellation and instrumentation applications.



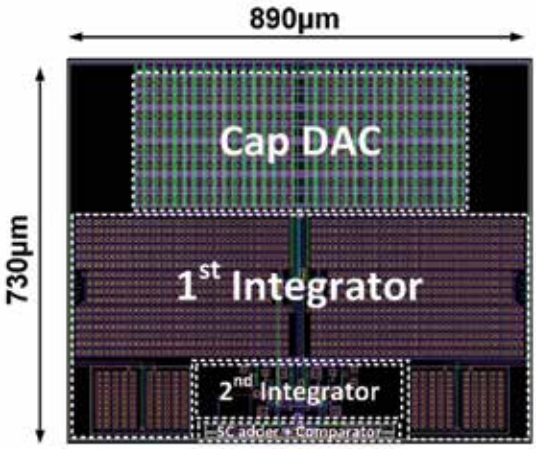
Huajun Zhang, Li Xu, Milad Moosavifar, and Zhehong Wang



Taewook Kang, Wootaek Lim, Teyuh Chou, and Hyunsoo Song



A 560µW Dynamic Zoom-ADC with 90.7dB SNDR for Audio Applications



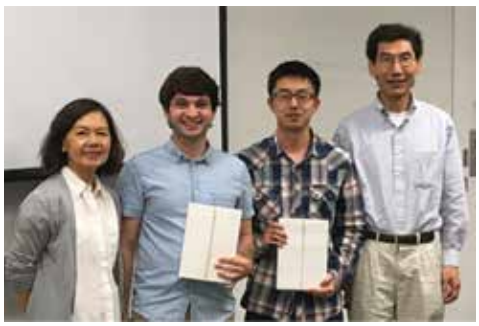
A 38 µW 19.1-bit incremental Zoom ADC with 2.2 V input range

{2010} MICHIGAN LAUNCHES FIRST OFFICIAL MOBILE APP

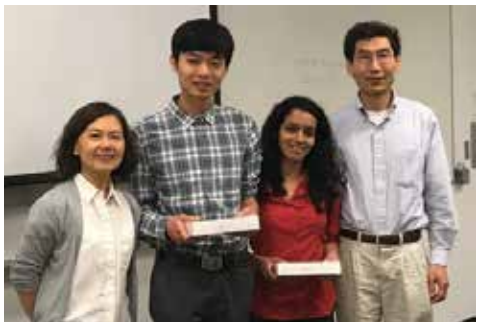
The first mobile app deployed by the University was originally developed by EECS students Mark Yang and Kevin Chan in Prof. Elliot Soloway's Mobile App Development course. They sold the app – which allowed users to navigate campus, track buses, read university news, and search the Directory – to the University's ITS group, who have maintained it since. The Michigan app continues to be available for iOS and Android phones.

Improving Image Processing Techniques

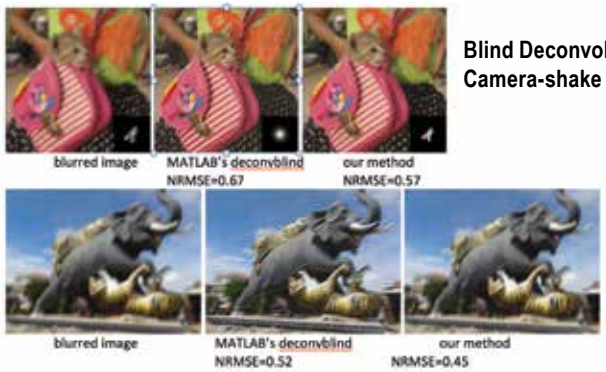
Two teams earned prizes in the graduate level course, EECS 556: Image Processing, thanks to the sponsorship of KLA-Tencor. The course, taught this past term by Prof. Boklye Kim (Radiology, EECS), covers topics in the theory of multidimensional signal analysis and processing with applications in optical, computerized tomography (CT), and magnetic resonance images. The projects focused on improving methods to reduce camera blur and facial recognition.



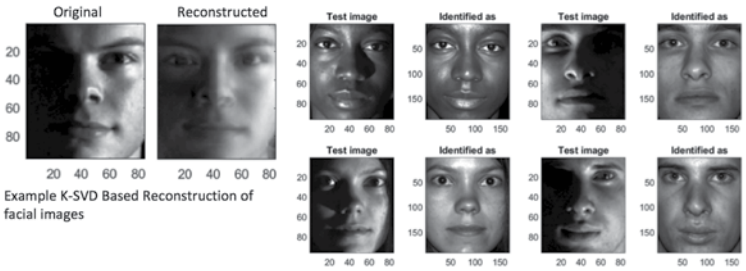
Prof. Boklye Kim, Cameron Blocker, Gong Cheng, and Dr. Hedong Yang, KLA-Tencor



L: Prof. Boklye Kim, Xianglong Wang, Tejaswi Worlikar, and Dr. Hedong Yang, KLA-Tencor



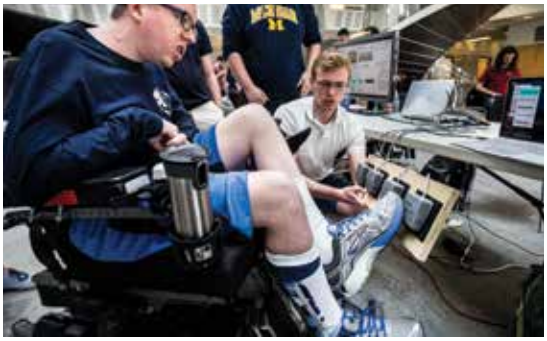
Blind Deconvolution of Camera-shake Motion Blur



Face Recognition via Dictionary-Based Sparse Image Representation

Students Develop Assistive Technologies With Personal Impact

India West is introduced to Dr. Chesney's class.



Students work with Brad Ebenhoeh on a footpedal computer navigation system.

Seniors in Computer Science are eager to take Dr. David Chesney's course, which is built around semester-long projects that have societal impact. Students are offered a challenge and have the opportunity to pitch solutions and then to join in teams and develop projects around top ideas. The challenges are real-world projects with an emphasis on the greater good, and have in recent years centered around assistive technologies for individuals with disabilities.

In Fall 2016, students met India West, a visually impaired 17-year-old, and proposed solutions to address some of her day-to-day difficulties. Projects that were developed included:

- a smart shelf, which could tell India what was on it and where
- a navigation app that stored favorite routes and played sounds in the direction to travel
- several audio-based tablet games
- a standard for putting RFID tags on objects so that they can announce themselves to a blind person who approaches
- computer coding lessons for the visually impaired

In Winter 2017, students met Brad Ebenhoeh, who has returned to Michigan as a 30-year-old Aerospace major. Brad suffered partial paralysis after a brain hemorrhage that occurred when he was a 19-year-old sophomore. Projects developed to assist Brad with mobility and his studies on North Campus focused on issues of control, selection, and accessibility.

Computer Games Showcase

In EECS 494, Game Design and Development, students learn the varied disciplines of game development, from 3D mathematics and game-engine architecture to player psychology and game design. Students apply this knowledge in the creation of classic games, small experimental games, and a large final showcase game for exhibition to the public at semester's end. Students gain experience in the C# programming language, physics, computer graphics, artificial intelligence, and in game design — all in the context of team-based software development.

In the project Train Track Trouble, friends battle atop high-speed locomotives.

Top games from the Fall 2016 section of the course were:

Ships Ahoy!
Built by Ward Chiang, Jessica Dou, Christopher Hsu, and Kelvin Tam

Spaced Out
Built by Amy Liu, Chris Pike, Yelena Pham, and Shane Schulte

Train Track Trouble
Built by Matthew Buckingham, Jack Knudson, Nicholas Tesija, and Kurt Waldowski

Top games from the Winter 2017 section of the course were:

Prehistoric Panic
By Lillian Huang, Andrew Lopez, Ori Lindner, and Gloria Park

Tentacle Turmoil
By Neil Banchero-Smith, Andrew Burrell, Michael Corcoran, and Hen Haim Sapir

Rocketeers!
By Justin Fan, Cameron Gagnon, Stephen Kline, and Alexander Wang

FOOOOD!
By Tianming Li, Hao Yang, Guangting Yu, and Tianyu Zhou

CSE Graduate Student Honors Competition

CSE held its thirteenth annual CSE Graduate Student Honors Competition on November 9, 2016. The competition is the culmination of a process that narrows a field of entrants to a handful of finalists, each of whom give a summary presentation on an area of their research. CSE faculty and an industry sponsor from Northrop Grumman rank the finalists' presentations.

First place went to **Shaizeen Aga** for her presentation, "Compute Caches."

Other finalists included:

Catherine Finegan-Dollak, "Effects of Creativity and Cluster Tightness on Short Text Clustering Performance"

Yuqing Kong, "Designing Information Elicitation Mechanisms That Reward Truth-telling"

Sang Won Lee, "Facilitating Collaborative Creation of Complex Artifacts"

Yu-Chih Tung, "Expansion of Human–Phone Interface by Sensing Structure-Borne Sound Propagation."

L-R: Catherine Finegan-Dollak, Yuqing Kong, Prof. John Laird, Diane Kakihara (Northrop Grumman), Yu-Chih Tung, Shaizeen Aga, Sang Won Lee

Shaizeen Aga (R), with her advisor Prof. Reetuparna Das

MHacks Gains Focus, Maturity as MHacks X Approaches

If there's one event at Michigan that reflects students' raw enthusiasm for hacking and building, it's MHacks, the infamous student-run hackathon.

The first MHacks took place on February 1-3, 2013, just as the student hackathon phenomenon began to blossom at college campuses nationwide. It hosted over 500 students, was crazy and euphoric, and at that moment in time was the biggest event of its kind.

Students show off their projects at the end of MHacks 9.

MHacks II was held September 20-22, 2013 and hosted over 1200 students in Michigan Stadium, once again claiming the title for the biggest and most outrageous college hackathon. MHacks events have continued to take place twice each academic year and are completely run by students, but the focus has shifted from competing with other hackathons for notoriety to an emphasis on event experience quality and on impact, from inclusion to accessibility.

During the 2016-2017 academic year, student organizers held MHacks 8 in Detroit from October 7-9, 2016 and MHacks 9 on North Campus from March 24-26, 2017.

MHacks 9 hosted 700 students and had two key initiatives: encouraging empathy-driven design and an increased focus on the local community.

According to Nevin Mital, MHacks Director of Logistics and undergraduate major in computer science and business administration, the idea for empathy-driven design was to encourage both better quality projects and well-rounded students by promoting design-oriented work-flow. "This meant encouraging participants to keep a true user-first approach in mind when bringing a project to life," said Mital. "We felt this was important because we can see the evolution of tech products in this direction."

In terms of focusing on the local community, the motivation was two-fold, according to Mital: "Detroit is being touted as the next design hub as its revitalization makes it a prime location for new and innovative discoveries, and we wanted to give back to the community in the same way it's supported us to this day. As such, we gave priority to local students and companies that were interested in being at MHacks and increased outreach to Michigan schools."

MHacks X will take place September 22-24 this fall, and in recognition of this milestone student organizers are planning for a larger event in the range of 1200 participants, to take place on North Campus. According to Mital, "We plan to celebrate the history and legacy of MHacks and the Hackathon Community by taking a look back from the beginning until the present day to pinpoint what it was that made each MHacks unique. We are also partnering with the SWE/TBP Career Fair to give students a better recruiting experience."

More information is available at mhacks.org.

Students gather for the closing ceremony at MHacks 9.

A History of MHacks

MHacks
February 1-3, 2013
Palmer Commons
500+ participants
Largest student-run collegiate hackathon

MHacks II
September 20-22, 2013
Michigan Stadium
1200+ participants
Largest student-run collegiate hackathon

MHacks III
January 17-19, 2014
The Qube, Detroit
1200+ participants
First off-campus event

MHacks IV
September 5-7, 2014
North Campus
1100+ participants
Adopt-A-Noob system and focus on education

MHacks V
January 16-18, 2015
North Campus
1000+ participants
Bleeding-edge mentorship program

MHacks 6
September 11-13, 2015
North Campus
1300+ participants
Introductory workshops and Women@MHacks

MHacks: Refactor
North Campus
February 19-21, 2016
700+ participants
1:1 female to male hacker ratio

MHacks 8
October 7-9, 2016
Detroit Masonic Temple
2200+ participants
Healthy Hacking initiative

MHacks 9
March 24-26, 2017
North Campus
700+ participants
Empathy-driven design and focus on local community

MHacks Nano
June 19-28, 2017
On-line
400+ participants
The first virtual MHacks

ArborHacks Hosts Second High School Hackathon

ArborHacks, the student group aimed at increasing access to CS by bringing collegiate-style hack events – with tons of support – to high school students, held its second annual hackathon on the weekend of November 19-20, 2016. High school students from Ann Arbor, Detroit, and Kalamazoo, as well as some students from Ohio and Pennsylvania, attended the event, which took place in the Beyster and Dow buildings on North Campus.

From 10 am-10 pm, fueled by a wealth of pizza and snacks for two days in a row, the high school students worked in teams of up to four people to build projects entirely of their own choosing. Numerous ArborHacks members were on hand to provide coaching, and event sponsors like Cisco, Carloop.io, and Particle.io brought incredible technologies for the students to use in their projects.

Students dived into their projects at ArborHacks 2.

According to Ben Freiband, ArborHacks co-President and CS major, “We were impressed by how students with little or no prior programming experience took the opportunity to learn and were able to develop websites, and even some projects that sent text messages or responded to the speed a car is going through its diagnostic port. They were enthusiastic and learned a lot!” In all, ten projects were completed by the student teams.

A project called “inTheMemeTime” sends texts of memes based on a category you specify.

Hacker Fellows Funded to Fuel Southeast Michigan Tech Companies

In a program that began in 2015, Invest Detroit Ventures is on a mission to help build the tech community in the Detroit Metro area. Each year, they fund a number of Hacker Fellows through a one-year program that places recent graduates with local early-stage tech companies. Fifteen Fellows from eight Michigan universities were selected as Hacker Fellows in 2016, including the following recent graduates from the University of Michigan:

Benjamin Willshire – BS CS 2016

Haitham Maaieh – BS CS 2016

Jessica Wu – BSE CS 2016

Shean Krolicki – BSE CS 2016

For the summer of 2017, Invest Detroit Ventures has created a new Hacker Fellow Summer Internship program. Ten interns were placed with local tech companies, including these students from Michigan:

Hanisha Arora – LSA undeclared

Cristian Guillen – LSA undeclared

Alexandria Kudlinski – Computer Science LSA

Seungyoun Lee – LSA undeclared

Junius Murphy – Computer Science LSA

CS Student's Four-Year Journey to Bring Music House to Michigan

Chris Salem (BS CS 2017) came to Michigan in Fall 2013 with an electric guitar, a keyboard, and an amp – and dreams of forming a student band. But he quickly learned that finding bandmates wasn't easy: many students didn't bring instruments, and there was no place on campus that an electric group could practice and play.

But while crossing the central campus diag one day that fall, Chris saw performances by a series of student ensembles. "I knew then," he said, "that somebody else had a passion for live music and was actually able to make this event happen."

Chris learned that a student group called Stamp Nation had organized the event. Formed in 2012 by Omar Hashwi (BBA 2014) and Amrutha Sivakumar (BSE IOE 2016), Stamp Nation was designed as a connector for non-music-major students and it organized twice-a-year diag performances.

Chris joined Stamp Nation that day and began pushing to expand its impact, arranging for weekly jam sessions and performances at the University's Canterbury House. Amrutha created the "Innovate Music Workshop," a six-hour immersive event that connects student musicians and introduces them to music and recording industry professionals. Chris, just entering the CS world, recollects that the idea "was for participants to end the workshop with a start-up idea in the music industry. It felt like MHacks."

Chris became president of Stamp Nation in 2016 after Omar and Amrutha graduated and accelerated plans for what he calls Music House. "Non-athlete students have lots of access to recreational facilities," said Chris. "But nothing similar exists for student musicians."

Chris has pursued this idea for the last three years and has submitted a proposal for it under the U-M Campus of the Future initiative. Chris graduated with a degree in CS in Winter 2017, but he continues to work with Stamp Nation leaders to design an event to be held at Canturbury House this fall, which will include performances, jam sessions, and workshops to demonstrate the idea of Music House and to build support for the proposal.

"CS and music have been my passions," states Chris. "I've been very fortunate to have been associated with the CS program; the computational thinking and engaging community that characterizes CSE has been an essential foundation for me in building Stamp Nation and advocating for Music House. It's really been a process, and I hope it's one that will benefit future students."

Students assemble and play together at a Stamp Nation jam session.

Student Leaders

The following EECS students served as leaders of a student organization or team:

David Adrian, Computer Science and Engineering Graduate Student Organization (CSEG) (President)

Robert Allen, Michigan Hackers (President)

Thomas Bartlett, Wolverine Soft (President)

Sarthak Bhandari, Code-M (President)

Johnathan Cha, Solar Car Team (Team Lead)

Kayla Fedewa, Girls in EECS (GEECS) (President)

Ben Freiband and **Josh King**, ArborHacks (Co-Presidents)

Ryan Gysin, Michigan Autonomous Aerial Vehicles (MAAV) (Team Lead)

Kanghwan Kim, Korean EECS Graduate Student Association (President)

Greg Ledva, ECE Graduate Student Council (President)

Lizzie Mamantov and **Lynn Garrett**, Ensemble of CSE Ladies (ECSEL) (Co-Chairs)

Meghna Menon, MHeal: Hybrid Infant Warmer (Project Team Lead)

Adarash Mishra, Intelligent Ground Vehicle (Team Lead)

Arun Nagpal, Students for the Exploration and Development of Space (Co-President)

Kit Ng, Amateur Radio Club (President)

Samuel Rumack, Michigan Mars Rover (President)

Cal Salisbury, Michigan Baja Racing (Team Captain)

Ankit Shah and **Matt Solarz**, Eta Kappa Nu (HKN) (Presidents in previous 2 terms)

Rebecca Sorgenfrei, UM::Autonomy (President)

Jonathan Stroud, Michigan Data Science Team (Organizational Chair)

Samuel Tenka, Michigan Student Artificial Intelligence Laboratory (MSAIL) (Chief Executive)

Kiran Thawardas, Project Music (President)

Reid Turbull, IEEE (President)

University and National Individual Honors and Awards

Nilmini Abeyratne (CSE graduate student) was selected for the Susan Lipschutz, Margaret Ayers Host and Anna Olcott Smith Award.

Yi-Jun Chang (CSE graduate student) has received a Chia-Lun Lo Fellowship for his research in complexity theory of distributed computing.

Qi Alfred Chen (CSE graduate student) has been awarded a Rackham Predoctoral Fellowship to support his research into network and system security.

Liz Dreyer (ECE graduate student) earned an Outstanding Collegiate Member Award for her years of leadership in SWE.

Paul Giessner (EE undergraduate student) earned a Utility Variable-Generation Integration Group Scholarship to support his education in wind and solar power.

Leonard Kapiloff (EE undergraduate student) earned a Power and Energy Society Scholarship to support his studies in a secure, sustainable grid.

Jack Kosaian (BSE in CS) has been awarded an NSF Graduate Research Fellowship to continue his research on data-intensive systems.

Sang Won Lee (CSE graduate student) has been awarded a Rackham Predoctoral Fellowship to support his research into the interactive systems that lie at the intersection of music and computer science. He also received the Student Music Award for best student composition at the International Computer Music Conference.

Noah Mitchell-Ward (EE undergraduate student) earned a Power and Energy Society Scholarship to support his studies on the environmental impacts of energy storage integration. Noah also earned a Utility Variable-Generation Integration Group Scholarship to support his education in wind and solar power.

Gopal Nataraj (ECE graduate student) received a U-M Rackham Predoctoral Fellowship to support his research in improved techniques in magnetic resonance imaging (MRI).

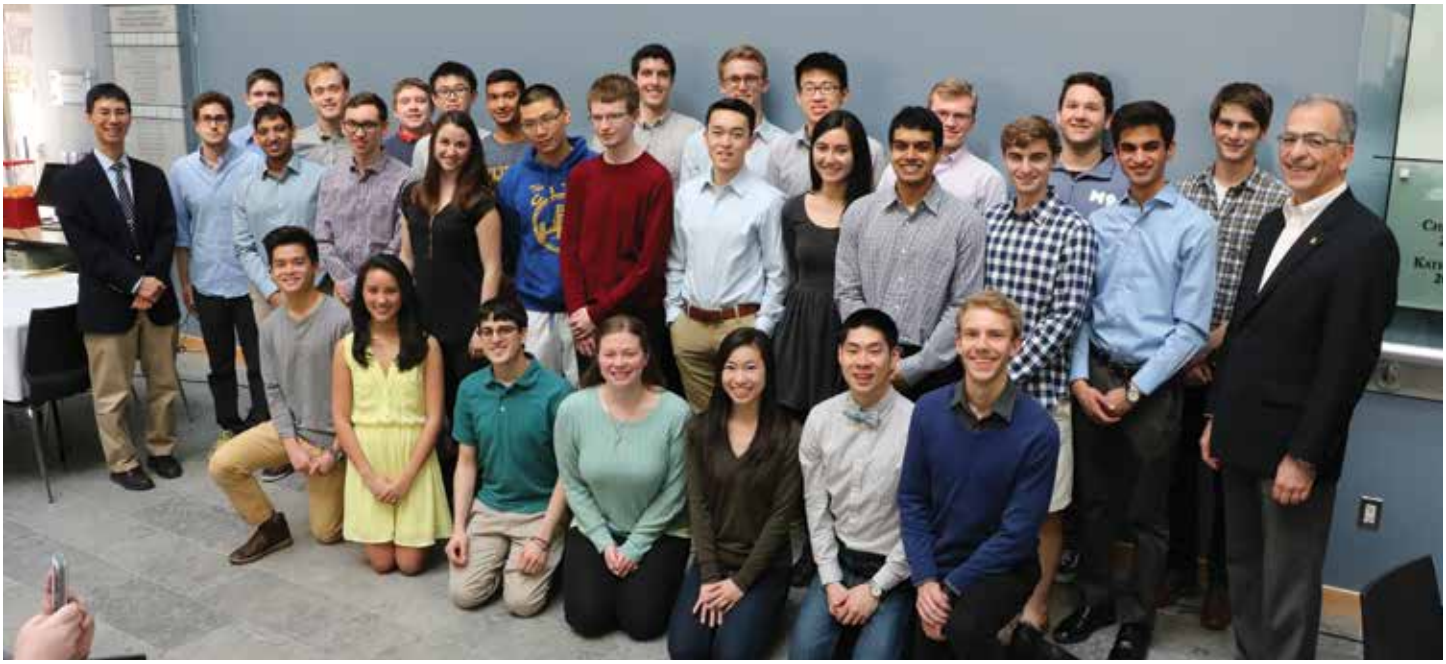
Andrew Quinn (CSE graduate student) received an NSF Graduate Research Fellowship and a Microsoft Research PhD Fellowship to research cluster-scale systems that allow developers to quickly understand and debug programs.

Timothy Trippel (CSE graduate student) was awarded an NSF Graduate Research Fellowship for his research in embedded systems and IoT security and privacy.

A classroom in the 1960s

Enlisted students taking a break during WWI

Photos courtesy Bentley Historical Library



EECS Awards

Undergraduate

Commercialization/ Entrepreneurship
Ziqi Guo (CS)
Michael Jin (CE)

Outstanding Achievement Award
Zihuan Diao (CE)
Maxwell Li (EE)
Kevin Shah (CS)

Outstanding Research Award
Zhihong Luo (EE)
Tara Safavi (CS)
Kevin Yang (CE)

Outstanding Service Award
Anna Dai (CS)
Melinda Kothbauer (CE)
Andrew Turek (EE)

Richard K. Brown Memorial Scholarship
Phil Ring (CE)
Aaron Zeller (EE)

William L. Everitt Student Award of Excellence
Yaman Abdulhak (CS)
Yifan Hao (CE)

William Harvey Seeley Prize
Joseph Costello (EE)
Paul Reggentin (EE)

College of Engineering Awards

Undergraduate

CoE Distinguished Leadership Award
Melinda Kothbauer (CE)
Kevin Shah (CS)

CoE Marian Sarah Parker Prize
Tara Safavi (CS)

CoE Mildred & Steele Bailey Prize
Anna Dai (CS)

Tau Beta Pi First-Year Award
Michelle Gu (CE)
Andrew Ramacher (CS)

CoE William H. Mack Engineering Prize
Alexander Meikle (EE)

Distinguished Achievement Award
Jovan Attisha (CE)
Kevin Shah (CS)
Andrew Wagenmaker (EE)

Graduate

CoE Richard and Eleanor Towner Prize for Outstanding PhD Research Award

Yu-Heng Cheng, EE PhD student, for "High-Efficiency Microfluidics for Single Cell Phenotypic and Genotypic Analysis of Rare Cancer Cells."

CoE Richard and Eleanor Towner Prize for Outstanding Graduate Student Instructors

Patrick Pannuto, CSE PhD student, conceived, designed, and initiated the course Computing for Computer Scientists (C4CS), which has grown to over 600 students registered in the last year.

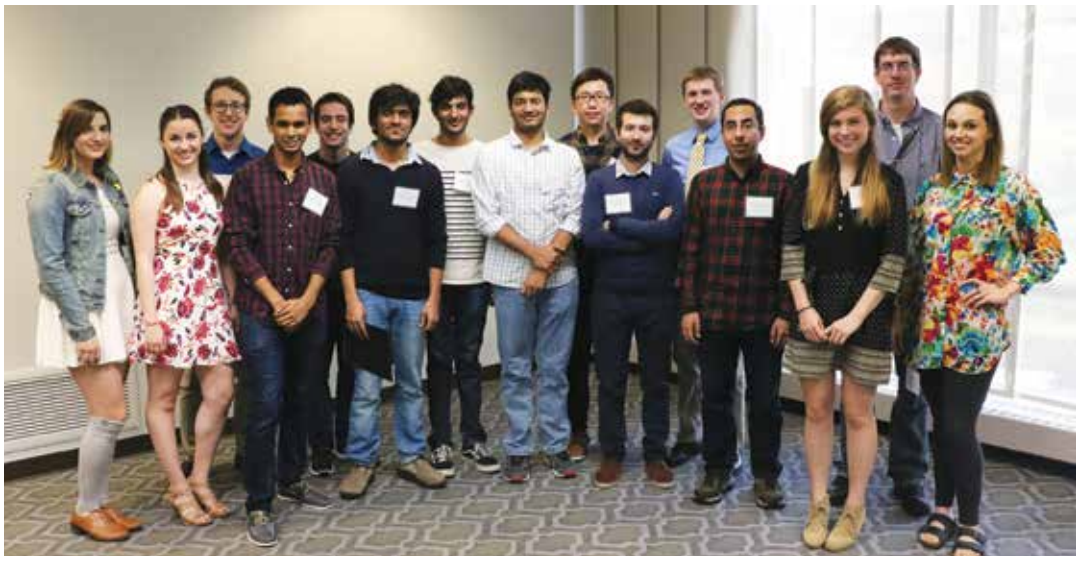
Nathan Sawicki (BSE MSE EE 2015 2017), developed music-based projects in the courses Intro to Signals and Systems (EECS 216) and Digital Signal Processing (EECS 351) which were highly interactive, enabling students to absorb a large amount of information without feeling overwhelmed

CoE Richard F. and Eleanor A. Towner Prize For Distinguished Academic Achievement

Gopal Nataraj, ECE PhD student

EECS Undergraduate and Graduate Student Teaching Awards

Graduate Student Instructors (GSIs) and undergraduate student Instructional Aides (IAs) are often essential to student success. The following students were selected based on student and faculty evaluations.



Award Winners

Baran Demir - GSI
Manav Gabhawala - IA
Paul Giessner - IA
Kyle Harman - GSI
Mohsen Heidari Khoozani - GSI
Cristina Noujaim - IA
Pranav Ramarao - GSI
Joel Sharin - GSI
Hannah Westra - IA
Steve Zekany - GSI
Nan Zheng - GSI

Honorable Mentions

Madeline Andrew - IA
Ishdeep Baid - GSI
Holly Borla - IA
Kristen Escher - GSI
Nathan Fenner - IA
Vaibhav Gogte - GSI
Tyler Siegel - IA
Andrew Springall - GSI

"Was on task, motivated, and clearly prepared."

"One of the strongest GSIs I have ever had."

"Pay this man more."

"Made class that much more entertaining and interesting."

"She's a boss."

Chez Betty Builds Community at CSE

Chez Betty is a 24/7/365 food co-operative that is housed in the Beyster Building. Founded in 2013 by CSE graduate students Brad Campbell, Zakir Durumeriç, and Pat Pannuto, Chez Betty has evolved from a small food stand to a centerpiece of day-to-day life in CSE.

Under its self-service honor system approach, customers swipe their MCard to log in, scan the barcodes of items they want, and are on their way. Anyone is welcome at Betty, and its 2,000+ users include students and faculty of all disciplines, support staff, and even a few deans!

Betty itself is open-source software and welcomes contributions for all, and writing additional code for Betty has even been included as part of an optional assignment in the department's introductory Computing for Computer Scientists course. Recently, Betty has seen integration into CSE research projects, adding automated monitoring of refrigerator and freezer health, as well as human flow throughout the space. Potential future enhancements include autonomous delivery of Betty goods via robots.

Chez Betty paused operation over the summer of 2017 for renovation and will reopen under the direction of CSE graduate student Brendan West in mid-Fall 2017. We're looking forward to it!

Congratulations to the following individuals who earned their Doctorate during the 2016–2017 Academic Year!

Sandunmalee Abeyratne, *Studies in Exascale Computer Architecture: Interconnect, Resiliency, and Checkpointing* (Profs. Ron Dreslinski Jr. and Trevor Mudge, Co-Chairs), CSE

Neha Agarwal, *Paving the Path for Heterogeneous Memory Adoption in Production Systems* (Prof. Thomas Wenisch, Chair), CSE

Azadeh Ansari, *Gallium Nitride Integrated Microsystems for Radio Frequency Applications* (Prof. Mina Rais-Zadeh, Chair), EE

William Arthur, *Control-Flow Security* (Prof. Todd Austin, Chair), CSE

Mahmood Barangi, *Straintronics: A Leap Towards Ultimate Energy Efficiency of Magnetic Memory and Logic* (Prof. Pinaki Mazumder, Chair), EE

Matthew Burgess, *Network Analysis on Incomplete Structures* (Profs. Eytan Adar and Michael Cafarella, Co-Chairs), CSE

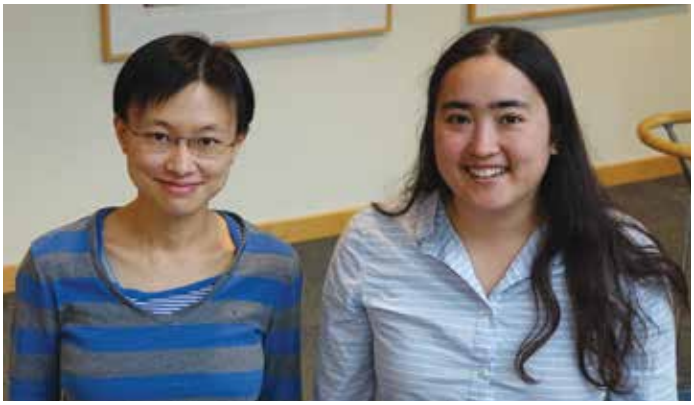
Farhad Shirani Chaharsooghi, *Structural Results for Coding Over Communication Networks* (Prof. Sandeep Pradhan, Chair), EE:Systems

David D. Chen-Zhang, *GNSS-R Remote Sensing of the Ocean: Surface Waves and Related Phenomena* (Prof. Christopher Ruf, Chair), EE

Pin-Yu Chen, *Analysis and Actions on Graph Data* (Prof. Al Hero, Chair), EE:Systems

Te-Hsuan Chen, *Designing Accurate and Low-Cost Stochastic Circuits* (Prof. John Hayes, Chair), CSE

Yajing Chen, *Designing Flexible, Energy Efficient and Secure Wireless Solutions for the Internet of Things* (Profs. Hun-Seok Kim and Trevor Mudge, Co-Chairs), CSE



Yen-Po Chen, *Low Power Techniques for Analog Building Blocks of the Ultra Low Power Systems* (Prof. Dennis Sylvester, Chair), EE

Hyun Jeong Cho, *Autofocus and Back-Projection in Synthetic Aperture Radar Imaging* (Prof. David Munson, Chair), EE:Systems

Jihyun Cho, *CMOS Sensors for Time-Resolved Active Imaging* (Prof. Euisik Yoon, Chair), EE

Jihun Choi, *Miniaturized Antenna and Wave Propagation Studies Enabling Compact Low-Power Mobile Radio Networks at Low VHF* (Prof. Kamal Sarabandi, Chair), EE

Michael Chow, *Scaling Causality Analysis for Production Systems* (Prof. Jason Flinn, Chair), CSE

Brandon Demory, *Making Semiconductor Single Photon Emitters Faster and Brighter* (Profs. P.C. Ku and Hui Deng, Co-Chairs), EE

Chao Du, *Metal Oxide Memristors With Internal Dynamics for Neuromorphic Applications* (Prof. Wei Lu, Chair), EE

Huan Feng, *Regulating and Securing the Interfaces Across Mobile Apps, OS and Users* (Prof. Kang Shin, Chair), CSE

Earlence Fernandes, *Securing Personal IoT Platforms Through Systematic Analysis and Design* (Prof. Atul Prakash, Chair), CSE

Laura Fick, *Neuromorphic Computation Circuits for Ultra-Dense Mobile Platforms* (Prof. Dennis Sylvester, Chair), EE

Xiaoxiao Guo, *Deep Learning and Reward Design for Reinforcement Learning* (Profs. Satinder Singh Baveja and Richard Lewis, Co-Chairs), CSE

Kristjan Greenewald, *High Dimensional Covariance Estimation for Spatio-Temporal Processes* (Profs. Al Hero and Shugeng Zhou, Co-Chairs), EE:Systems

Johann Hauswald, *System Design for Intelligent Web Services* (Profs. Jason Mars and Lingjia Tang, Co-Chairs), CSE

Davoud Jamshidi, *Accelerating Data Transfer for Throughput Processor* (Prof. Scott Mahlke, Chair), CSE

Taehee Jang, *Transparent and Flexible Radio Frequency (RF) Structures* (Prof. Jay Guo, Chair), EE

Supreet Jeloka, *Cross-Point Circuits for Computation, Interconnects, Security and Storage* (Prof. David Blaauw, Chair), EE

Seok Hyeon Jeong, *Ultra-Low Power Circuits for Internet of Things (IOT)* (Prof. Dennis Sylvester, Chair), EE

Xiaoen Ju, *Efficient Large-Scale Graph Processing* (Prof. Kang Shin, Chair), CSE

Hyunsoo Kim, *Organic Photodiodes and Their Optoelectronic Applications* (Prof. Jerzy Kanicki, Chair), EE

Jaeyoung Kim, *Ultra Low-Power Wireless Sensor Node Design for ECG Sensing Applications* (Prof. Pinaki Mazumder, Chair), EE

Kyu Hyun Kim, *Development of Optomechanical Sensors Using Capillary-based Microfluidic Ring Resonators* (Profs. Duncan Steel and Xudong Fan, Co-Chairs), EE

Aasheesh Kolli, *Architecting Persistent Memory Systems* (Prof. Thomas Wenisch, Chair), CSE

Jae Sang Lee, *Lifetime and Efficiency of Blue Phosphorescent Organic-Light Emitting Diodes* (Prof. Stephen Forrest, Chair), EE

Kyungmin Lee, *Improving Usability of Mobile Applications Through Speculation and Distraction Minimization* (Profs. Jason Flinn and Brian Noble, Co-Chairs), CSE

Suho Lee, *Unbounded Scalable Hardware Verification* (Prof. Karem Sakallah, Chair), CSE

Che-Hung Liu, *Graphene Transistor Based Nanoelectronic and Nanophotonic Applications* (Prof. Zhaohui Zhong, Chair), EE

Andrew Lukefahr, *Composite Cores: Improving Energy Efficiency Through Fine-Grained Heterogeneity* (Profs. Reetuparna Das and Scott Mahlke, Co-Chairs), CSE

Biruk Wendimagegn Mammo, *Reining in the Functional Verification of Complex Processor Designs With Automation, Prioritization, and Approximation* (Prof. Valeria Bertacco, Chair), CSE

Jonathon Martin, *Model-Predictive Control for Alleviating Transmission Overloads and Voltage Collapse in Large-Scale Electric Power Systems* (Prof. Ian Hiskens, Chair), EE:Systems

Travis Martin, *Theoretical Tools for Network Analysis: Game Theory, Graph Centrality, and Statistical Inference* (Profs. Mark Newman and Michael Wellman, Co-Chairs), CSE

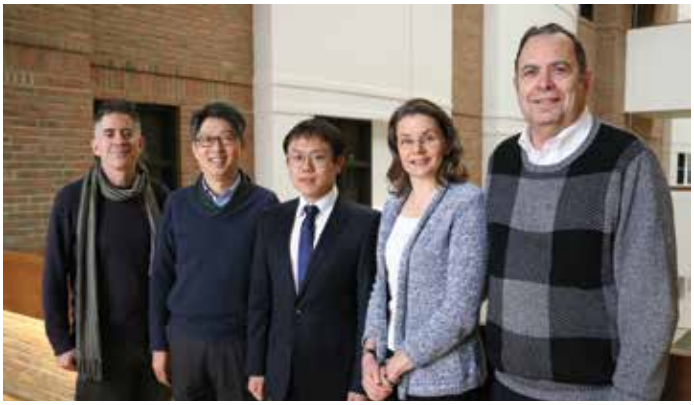
David Merritt, *Leveraging Mixed Expertise in Crowdsourcing* (Prof. Mark Ackerman, Chair), CSE

Shankar Mohan, *Control of Lithium-Ion Battery Warm-Up From Sub-Zero Temperatures* (Prof. Anna Stefanopoulou, Chair), EE:Systems

Cameron Nelson, *Coherent Nonlinear Optical Spectroscopy of In-GaN Disks in GaN Nanowires* (Prof. Duncan Steel, Chair), EE

Sechang Oh, *Low-Noise Energy-Efficient Sensor Interface Circuits* (Prof. Dennis Sylvester, Chair), EE

Shruti Padmanabha, *Energy Efficient Heterogeneous Processor Architectures for General Purpose Applications* (Profs. Reetuparna Das and Scott Mahlke, Co-Chairs), CSE



Jason Jong Kyu Park, *Enabling Efficient Resource Utilization on Multitasking Throughput Processors* (Prof. Scott Mahlke, Chair), CSE

Adam Peczalski, *Piezoelectric Fused Silica Resonators for Timing References* (Prof. Maina Rais-Zadeh, Chair), EE

Connie Qiu, *Composite Adaptive Internal Model Control: Theory and Applications to Engine Control* (Profs. Mrdjan Jankovic and Jing Sun, Co-Chairs), EE:Systems

Amir Rahmati, *Attacking and Defending Emerging Computer Systems Using The Memory Remanence Effect* (Prof. Atul Prakash, Chair), CSE

Scott Reed, *Deep Neural Networks for Visual Reasoning, Program Induction, and Text-to-Image Synthesis* (Prof. Honglak Lee, Chair), CSE

Sanae Rosen, *Improving Mobile Network Performance Through Measurement-Driven System Design Approaches* (Prof. Z. Morley Mao, Chair), CSE

Richard Sampson II, *Architectural Support for Medical Imaging* (Prof. Thomas Wenisch, Chair), CSE

Shurun Tan, *Multiple Volume Scattering in Random Media and Periodic Structures With Applications in Microwave Remote Sensing and Wave Functional Materials* (Prof. Leung Tsang, Chair), EE

Ryan Wolcott, *Robust Localization in 3D Prior Maps for Autonomous Driving* (Prof. Eustice Ryan, Chair), CSE

Yalcin Yilmaz, *Bio-inspired Hardware Architectures for Memory, Image Processing, and Control Applications* (Prof. Pinaki Mazumder, Chair), EE

Xiang Yin, *Property Enforcement for Partially-Observed Discrete-Event Systems* (Prof. Stéphane Lafortune, Chair), EE:Systems

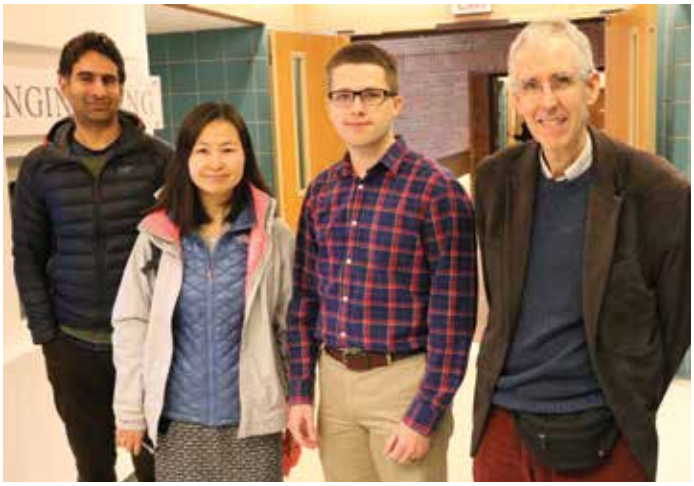
Chenliang Xu, *Scale-Adaptive Video Understanding* (Prof. Jason Corso, Chair), CSE

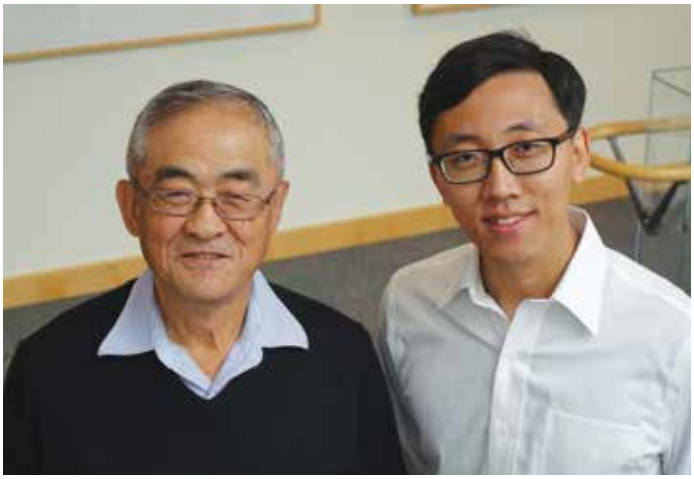
Zhao Xu, *Terahertz (THz) Waveguiding Architecture Featuring Doubly-Corrugated Spoofed Surface Plasmon Polariton (DC-SSPP): Theory and Applications in Micro-Electronics and Sensing* (Prof. Pinaki Mazumder, Chair), EE

Chunyang Zhai, *Building Blocks for Sampling and Digitization in High-speed Communication Systems* (Prof. Michael Flynn, Chair), EE

Chumin Zhao, *High Resolution Active Pixel Sensor X-Ray Detectors for Digital Breast Tomosynthesis* (Prof. Jerzy Kanicki, Chair), EE

Jiantao Zhou, *Resistive Switching Memory and Reconfigurable Devices* (Prof. Wei Lu, Chair), EE

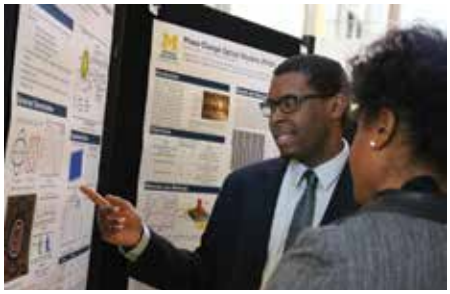




ECE Students and Alumni Meet Over Research at the 2016 Graduate Symposium

Systems to study cancer stem cells, new methods to remotely measure snow and ice thickness, radar for autonomous vehicles, navigation systems that don't rely on GPS, nanowire lasers, and methods to model lithium-ion batteries were just a few of the many winning projects presented by ECE students at the 2016 Engineering Graduate Symposium.

Posters and presentations were judged by faculty and a visiting group of thirteen returning ECE alumni, and winners were chosen in each area of study. Thirteen ECE students were recognized as 1st or 2nd Place in their division, and one presenter earned a Towner PhD Research Award.



Applied Electromagnetics and Plasma Science

Mohammad Mousavi – 1st place, for "Elevation Angular Dependence of Wideband Autocorrelation Radiometric (WiBAR) Remote Sensing of Dry Snowpack and Lake Icepack." Advised by Kamal Sarabandi.

Armin Jam – 2nd place, for "A Novel Sub-Millimeterwave Radar System for Autonomous Vehicle and Collision Avoidance Applications." Advised by Kamal Sarabandi.

Fatemeh Akbar – 3rd place, for "A Novel Integrated Scalable Phased Array with a Reduced Number of Phase Shifters." Advised by Amir Mortazawi.

Shurun Tan – 4th place, for "Modal Representation of Broadband Green's Function with Applications in Periodic Structures." Advised by Leung Tsang.

Integrated Circuits, VLSI, and Microsystems

Christopher Boyd – 1st place, for "Low-Noise MEMS Gyroscope System for Navigation." Advised by Khalil Najafi.

Tal Nagourney – 2nd place, for "130 Second Ring-Down Time and 3.98 Million Quality Factor in 10 kHz Fused Silica Micro Birdbath Shell Resonator." Advised by Khalil Najafi.

Medicine and Translational Research

Zhixiong Zhang – 2nd place, for "Scalable Multiplexed Drug-combination Screening Platform Using 3D Microtumor Model." Advised by Euisik Yoon.

Optics, Photonics, and Solid-State Devices

Youngbae Son – 1st place, for "In-situ Chemical Modification of Schottky Barrier in Solution-Processed Zinc Tin Oxide Diode." Advised by Becky Peterson.

Arnab Hazari – 2nd place, for "III-Nitride Monolithic Nanowire Array Edge-Emitting 1.3 μm Diode Laser on (001) Silicon Substrate." Advised by Pallab Bhattacharya.

Justin Easley – 3rd place, for "Variable-Field Hall Effect Analysis of HgCdTe Epilayers with Very Low Doping Density." Advised by Jamie Phillips.

Power and Energy

Jonas Kersulis – 1st place, for "Renewable Voltage Regulation, Transformer Parameters, and a Tapping Tradeoff." Advised by Ian Hiskens.

Bin Wu – 2nd place, for "Mechanical Modeling of Agglomerate in Lithium-Ion Battery Electrodes." Advised by Wei Lu.

System and Communication Engineering

Mohammad Rasouli – 1st place, for "Scalable Control of Cyber-Physical Systems." Advised by Demosthenis Teneketzis.

Mehrdad Moharrami – 2nd place, for "Impact of Community Structure on Cascades." Advised by Mingyan Liu.

Signal and Image Processing, Computer Vision

David Hong – 1st place, for "Predicting the Asymptotic Performance of Rank-1 PCA with Heteroscedastic Data." Advised by Jeff Fessler.

Lianli Liu – 2nd place, for "Female Pelvic Synthetic CT Generation Based on Joint Shape and Intensity Analysis." Advised by Jeff Fessler.

Are you an alumnus of Electrical and Computer Engineering wanting to connect with fellow alumni in your industry? Do you have knowledge to share with current students?

AIM (Alumni Interactive Mentoring) is an online network designed for you to connect with fellow alumni and serve as a mentor to ECE students. Go to: eceaim.xinspire.com to begin making connections and building your network.

If you have questions regarding AIM or any other alumni programs or events in ECE, please email our Alumni Relations Manager, Kristin McDonough at kjmcdono@umich.edu.

AIM
Alumni Interactive Mentoring

eceaim.xinspire.com

Alumni

NEWS

NADER BEHDAD: ECE's 1st Rising Star Uses Antennas to Microwave Away Cancerous Tumors

Nader Behdad (MS PhD EE 2003 2006) is the inaugural recipient of the ECE Rising Star Alumni Award, which recognizes younger ECE alums who have achieved early success within their careers. Behdad has tackled some of the biggest problems in antenna research – with some of the smallest antennas. Recently, he's even made them small enough to be used to treat cancer.

As the Harvey D. Spangler Faculty Scholar in the Department of Electrical and Computer Engineering at the University of Wisconsin-Madison, Behdad and his group work to address several tough problems in applied electromagnetics. In particular, his research interests include electrically-small antennas, antenna arrays, antennas for biomedical applications, and biomedical applications of RF/microwaves.

Recently, the group has applied their technology to cancer treatment. Behdad and colleagues have designed a minimally-invasive antenna that can be used for ablation, the surgical removal of tissue. The goal is for this small device to essentially microwave away tumors, heating them from within until the malignant cells begin to die off.

Existing work in this area has been almost exclusively restricted to lower-frequency microwaves, but Behdad's group found that higher frequency ablation can achieve the same results while potentially allowing for much smaller antennas. Eventually, the group hopes to design long, flexible antennas that can be routed to the tumor and allow for very precise treatment.

With nine issued U.S. patents and six more in the pipeline, he may turn his attention one day to commercializing his technology. But for now, the thrill of discovery and satisfaction that comes from working on problems that will improve people's lives in a tangible way keeps him happy, and moving forward in new directions.

Behdad visited Michigan to receive the award, and presented the lecture, "High-Frequency Microwave Ablation Antennas for Minimally-Invasive Treatment of Cancer," on November 11, 2016.

Nader Behdad uses antennas to microwave away cancerous tumors.

"When you start trying to solve a problem, maybe 9 out of 10 ideas don't work. But sometimes half of those 9 things that don't work are actually solutions to other problems."

{2001} TONY FADELL: The Iconic iPod

Tony Fadell (BSE CE 1991) led the entrepreneurially-minded engineering team that developed the groundbreaking iPod MP3 player in 2001. He followed that by leading the creation of the revolutionary iPhone (2007), and later formed the company Nest to bring us its connected learning thermostat (2011).

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NANCY BENOVICH GILBY: Educator and Entrepreneur

Nancy Benovich Gilby (BSE CE 1985, MSE CSE 1987) is an educator and entrepreneur with 10 successful high-tech startups and many years of accomplishment as an educator and curriculum developer.

Benovich Gilby worked at U-M's School of Information from 2014-2017 as its first Ehrenberg Director of Entrepreneurship, after serving as a mentor to Michigan students interested in entrepreneurship for seven years through the U-M Center for Entrepreneurship. She developed the school's entrepreneurial curriculum for its Bachelor of Science in Information program, which launched in 2014. In addition to coordinating entrepreneurial partnerships with other departments and schools at the university, she has expanded the school's participation in events such as national competitions, startup treks, networking opportunities, and client engagement. Benovich Gilby also serves on the advisory board for CSE.

A native Michigander, Benovich Gilby grew up in working class Warren, just north of downtown Detroit. Although she excelled in math and would become class valedictorian, she didn't consider the possibility of attending the University of Michigan until a math teacher pushed her to apply.

While an engineering student at Michigan in the 1980s, Benovich Gilby landed a job in Dean James Duderstadt's office that exposed her to planning and vendor presentations for a computing transition under which all users would move from large multi-user, mainframe systems to next-generation computing workstations. This first-hand view of powerful entrepreneurial thinking had a deep impact on her, igniting her imagination and spurring her to chart her own journey to make change through entrepreneurial endeavor.

"My experiences at Michigan were key to inspiring me and enabling my success as an entrepreneur in the fast-paced tech sector. My focus now is to give back by providing support, encouragement, and that 'push' so that more women and entrepreneurs can achieve their dreams," says Benovich Gilby. "You can do it!"

Benovich Gilby recently became the first-ever recipient of the Michigan Council of Women in Technology (MCWT) Foundation's Woman of the Year Award. She was honored with the award at MCWT's annual Orange Carpet Gala on November 5, 2016 in Detroit.

{1949} IRMA WYMAN

Irma Wyman (BSE EngMath 1949) was a pioneer in the field of computers, beginning with her work on some of the earliest programmable machines ever made. As the first female vice president at Honeywell, she knew success – but she also knew firsthand how rare she was to succeed in a field where women were scarce. In the photo, she is explaining to men from the U.S. Treasury how a computer could help them manage their business. She established the Irma M. Wyman Scholarship to support women in engineering and computer science.

UNIVERSITY OF MICHIGAN BICENTENNIAL

Photo courtesy Bentley Historical Library

RICK BERGMAN: CEO of Synaptics – Giving Tech a Sense of Touch

A good user interface can be the difference between a useful gadget and a forgettable dud. Touchscreens turned cellphones into intuitive pocket computers, and accurate sensors opened up the world of wearables.

Rick Bergman (BSE EE 1986), CEO of Synaptics, is working to make tomorrow's technology user friendly, safe, and reliable. With Synaptics' 1900+ granted and pending patents for common human interface technologies like touch sensors, display drivers, and biometric sensors, he hopes to lead "the human interface revolution."

By the time of Bergman's arrival, Synaptics had already built a strong reputation in the human interface world. Their first major breakthrough, the now-prolific touchpad, helped make laptops thinner and propel them into the consumer market. Bergman now leads a nearly $2 billion company whose capacitive touch technology can be found in devices around the world.

After graduating from Michigan, Bergman took a position at Texas Instruments as a marketing manager – a conscious decision to step out of his comfort zone. Throughout the late 1990s and 2000s, Bergman took leadership positions at companies of all sizes, eventually working as Senior VP and general manager at AMD's Graphics Product Group.

Bergman and Synaptics are pushing the state-of-the-art in the handheld, wearable, and IoT world. The company recently developed optical sensors that enable fingerprint reading through full cover glass thickness, and acquired companies that focus on voice and video processing solutions for smart homes. It has also moved into the world of touch technology in automotive applications.

"I was excited by the opportunity to participate in a company that was revolutionizing the industry," said Bergman. "The real opportunity in a mid-sized technology company is to propel its growth into new, exciting markets. My focus for the years that I've been here is to do exactly that with these world-class technologies."

"Michigan gave me a fundamental foundation that I continue to leverage today, 20 years later."

ANGELA BLANTON: From Engineering to Finance

Angela Blanton (BSE EE 1993) is vice president for Finance and chief financial officer for Carnegie Mellon University. After graduating from U-M, she worked at Delphi and Chrysler Motors Corp. as an electrical engineer. She then returned to academia to earn her MBA from the Tepper School of Business at Carnegie Mellon University (CMU). She returned to her second alma mater after 9 years at PPG Industries and another 8 years at PNC, where she rose to the rank of VP and CFO at PNC Financial Services.

"Engineering and finance require strong teamwork as well as analytic and problem-solving skills," said Blanton. "My process orientation as an engineer has been invaluable in my efforts in finance to streamline processes and increase effectiveness. Both fields require constantly looking for opportunities to improve processes and performance."

At CMU, Blanton is responsible for providing strategic leadership for the university's business and finance functions, as well as for the management of its financial and capital resources. She oversees Audit Services, Treasurer's Office, Controller's Office, Procurement Services, Budget and Financial Planning, and Business Systems and Services.

Blanton was a part of the leadership teams for two different employee business resource groups at PNC, African-American Employee Business Resource Group (EBRG), and Finance Diversity EBRG, allowing her to advise executive management on diversity issues. Now a part of CMU's senior leadership team, she regularly participates in discussions about creating a collaborative, interdisciplinary environment.

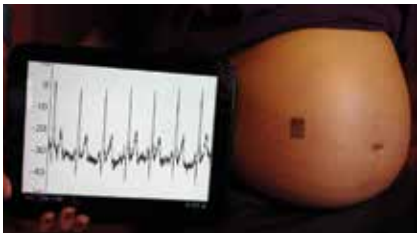
"Attending the University of Michigan helped me to develop an appreciation for the role research universities play in addressing problems that are important to society."

"I'm very proud to be a part of a university community that is making great strides in building a culture of support for women in technology."

TODD COLEMAN: Sensors From Head to Toe

Prof. Todd Coleman (BSE CE EE 2000) and his group at the University of California, San Diego, are working to achieve affordable, high-fidelity health monitoring at home. To do this, they created sensors as thin as skin that can gather data from nearly anywhere.

Coleman's research resides at the intersection of information theory and neuroscience. A decade ago, he was working with brain-machine interfaces, which allow you to control robotic arms, simulations on a screen, and even remote control airplanes with your mind. He saw the potential in interpreting and manipulating brain signals, but the existing technology was far from comfortable or portable. So Coleman embarked on designing new interfaces to measure bodily signals. "There were no wearables yet back then," he says. "We pretty much had to invent our own flexible electronic systems to measure these different signals."



His current group has applied this technology to a number of different situations, including sleep monitoring, newborn infants, and pregnancy. All of these applications share the issue of working around clunky, difficult equipment, and Coleman hopes to miniaturize them all.

His systems for monitoring pregnancy are about as thick as a human hair, and can be manufactured using the same processes as a computer chip. Shrinking existing systems is just one goal of the Coleman group. In a new project, he and his students hope to apply their thin sensors to measure gastrointestinal health – an area that has until now gone largely unexplored.

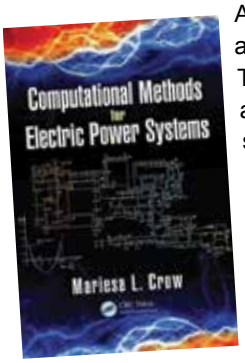
Coleman's research has been featured on CNN, BBC, and the *New York Times*, and his TED talks have attracted nearly a million views. His nearly 20 students and researchers (including a number of Michigan alumni) collaborate with researchers throughout the university, taking advantage of connections to UCSD's research hospital and neuroscience department.

"I was able to take my knowledge of information theory and use it as the language to learn about medicine and neuroscience. In the back of my mind I began to wonder how I could apply this hardcore theory to help people's lives."

MARIESA CROW: Looking to the Future of Power

Mariesa Crow (BSE EE 1985) is working to power the future through her research on energy storage and microgrids and her commitment to training the next generation of power engineers. The Fred Finley Distinguished Professor of Electrical Engineering and VP for Research at Missouri S&T, Crow found her way to the field of power thanks to her PhD advisor at the University of Illinois, who she looked up to as a prominent woman in her field.

Crow researches energy storage technology and how it can be used to stabilize the power grid. This includes exploring how energy storage can be used to integrate renewable energy sources into the grid and act as a buffer for unreliable solar and wind power generators. In particular, she examines microgrids, which can range in scope from a single building to a small community or campus. Crow has helped develop modular renewable power grids for military forward operating bases, to provide power that is easily transported and requires no permanent infrastructure. "Because these renewable systems are small, you can put them together like LEGO's," said Crow.



As part of the NSF Center for Future Renewable Electric Energy Delivery and Management (FREEDM), Crow works to develop the "internet of energy." This would allow consumers to plug in and out of the grid seamlessly and control how they get their power. She leads the center's large-scale simulation testbed.

Crow is also involved in a number of activities to train the next generation of energy professionals. For the past three years, she has led the Mid-America Regional Microgrid Education and Training Consortium, and she works with universities across the region to develop undergraduate and graduate curricula and train working engineers to face new challenges. Her textbook, *Computational Methods for Electric Power Systems*, is in its third edition.

"As we move toward a new smart grid, traditional power engineering techniques are changing. We need a new curriculum for that."

RHONDA FRANKLIN: Connecting Diverse Students

Rhonda Franklin (MSE PHD EE 1990 1995) uses her influence as a professor at the University of Minnesota to attract a diverse student population to the STEM field, and her own field of applied electromagnetics. She believes the best research results are achieved from a diversity of backgrounds, something she learned as a graduate student at Michigan and fosters in her own research group at Minnesota.

To "connect with and to provide science, technology, engineering, and math enriching opportunities to underrepresented undergraduate college students," Franklin co-founded the IEEE Microwave Theory and Techniques Society's International Microwave Symposium (IMS) Project Connect. She also encouraged a group of undergraduate women to form an IEEE Women in Engineering program on campus, now in existence. Her own research group participates in summer outreach campus programs for undergraduates and off-campus community programs.

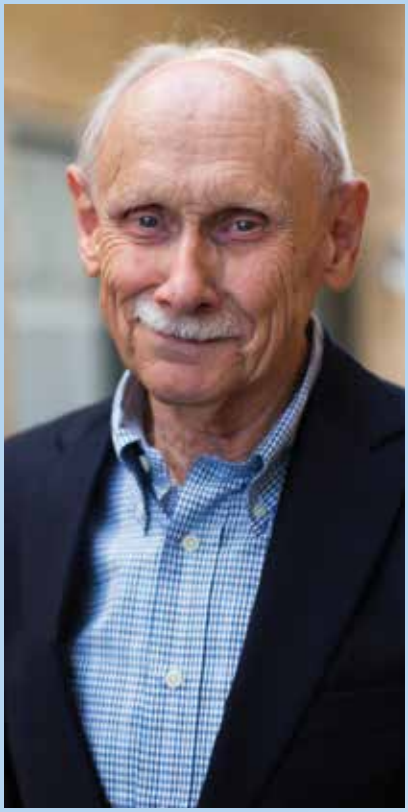
Franklin's research group, called Microwave Packaging and Circuit Technology (MPACT), focuses on the use of Microelectronic Mechanical Structures (MEMS) in radio frequency (RF) and microwave applications related to wireless, mobile, and satellite communications systems.

She enjoys collaborating with others, and is currently working with a materials scientist who makes magnetic nanowires. Before that she worked with a microbiologist who wanted to know how bacteria conducts current.

"We built the circuits that he grew his bacteria on," said Franklin, "which allowed him to study the current production of this bacteria. So here's a microbiologist who understands how to grow bacteria and then you have me who's a circuit designer trying to get those two worlds to come together. It was fascinating."

"I think that women have always been engineers, it's just that we've been engineering things that you don't get paid to do."

ELMER GILBERT: A Life in Control



Elmer G. Gilbert (BSE MSE EE 1952 1953, PhD Instrumentation Engineering 1957), professor emeritus of Aerospace Engineering and Electrical Engineering and Computer Science, treated the engineering community to a talk about his career in control systems on March 24, 2017.

Gilbert was a leader in the development of new theory and applications in the area of control systems, moving frequently between mathematical system theory and hardware. In control theory, he is well known for the "Gilbert realization," still a standard topic in systems textbooks, and developed the foundational results for control over a moving horizon, which underlies model predictive control (MPC). On the hardware side, he was a key member of the design group responsible for the conception and development of analog hybrid computer systems, and an inventor of high-performance computer devices.

A key 1988 paper on model predictive control was the first contribution to address in specific, rigorous ways stability issues crucial in many current control applications.

Prof. Gilbert is a member of the National Academy of Engineering, and Fellow of IEEE and the American Association for the Advancement of Science. He has received numerous awards, including the Richard E. Bellman Control Heritage Award, and the IEEE Control Systems Award. He co-founded Applied Dynamics, International in 1957, and was a key member of the Applied Dynamics group responsible for conception and development of new products, primarily state-of-the-art analog and hybrid computers, through 1970. He holds 9 patents in simulation and control technology.

Gilbert's talk is available on Youtube and available with transcription here: http://ethw.org/First-Hand:Reminiscences_on_My_Career_in_Control. He was introduced by Jessy Grizzle, Elmer G. Gilbert Distinguished University Professor of Engineering.

WON PYO HONG: ECE Alumni Impact Award

Won Pyo Hong (MSE PhD EE 1984 1988), President of Samsung SDS, is the inaugural recipient of the ECE Alumni Impact Award. This award, established in 2017, recognizes Dr. Hong for his pioneering work in the personal electronics industry. It is the highest recognition granted by ECE to its alumni.

Khalil Najafi, Peter and Evelyn Fuss Chair of Electrical and Computer Engineering, Dr. Won Pyo Hong, and Pallab Bhattacharya, Charles M. Vest Distinguished University Professor, James R. Mellor Professor of Engineering, and Dr. Hong's PhD advisor

Hong is President of Samsung SDS, a global information technology and services company employing more than 10,000 individuals. He is an established authority and industry leader in IT, mobile and Internet of Things (IoT) space. Before assuming his current position, he was the President and Chief Marketing Officer of Samsung Electronics and played a critical role in positioning Samsung as the world's premiere handset manufacturer and global brand.

Dr. Hong joined Samsung in 2007 in the Network Infrastructure Business Division. Within a year, he became head of the Global Product Strategy Team for the Mobile Communications Business Division. It was in this role that he was responsible for the overall product strategy of the Samsung GALAXY mobile phone series, one of the most hotly anticipated and ultimately best-selling mobile devices in history.

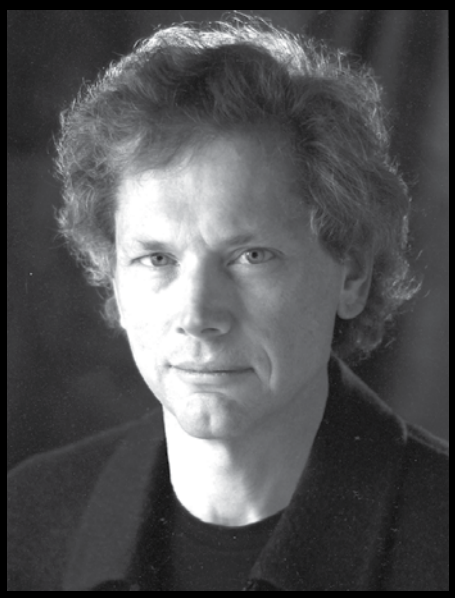
In 2015, Dr. Hong was named President and Chief Marketing Officer of Samsung Electronics, as well as Head of its Global Marketing Office. In this capacity, he worked to expand the company's investment and development in the Internet of Things, a market that's expected to exceed $7T by 2020.

Hong visited Michigan to receive the award, and presented the lecture "Samsung Innovation" on April 10, 2017.

"Smart phones connect us not only with people, but with wearable devices, cars, and smartphone technologies."

{1982} BILL JOY: SUN MICROSYSTEMS, UNIX, JAVA

Bill Joy (BSE CE 1975) co-founded Sun Microsystems in 1982, and served as chief scientist of the company until 2003. He developed a version of UNIX while a graduate student at UC-Berkeley that included TCP/IP networking protocols — conventions that became the backbone of the modern Internet. In 1995, he unveiled Java, which has been integral to the development of Internet business, and he is the original author of the vi text editor. Joy is a member of the National Academy of Engineering, and has been called the "Edison of the Internet."



TIM HOWES: An Entrepreneurial CTO

Tim Howes (BSE Aero 1985, MSE PhD CSE 1987 1996), entrepreneur and computer scientist, is currently the chief technology officer at ClearStory Data, a leading provider of cloud-based fast-cycle big data analytics.

Dr. Howes' doctoral research focused on Internet directory services, and he co-invented LDAP, the Internet directory protocol, while a graduate student at U-M. Howes left Ann Arbor for Silicon Valley after his PhD, where he became CTO of Netscape's server products division and a Netscape Fellow.

Howes co-founded Opsware in 1999 (when it was called Loudcloud), where he served as CTO, President of Product Operations, and EVP of Engineering. Opsware was sold to HP in 2007 for $1.65B. He served as CTO of HP Software and then left to co-found Rockmelt, which was sold to Yahoo in 2013. He served as VP Engineering of Yahoo's Mobile and Emerging Products division through the end of 2014. Dr. Howes currently serves as CTO of ClearStory Data, and as co-CEO of Know Yourself, a public benefit corporation he co-founded with his wife, dedicated to making Self Literacy as fundamental to early education as the ABCs and 123s.

He has co-authored two books, over 20 Internet RFCs, and holds numerous patents. He has served on the IETF's Internet Architecture Board, and the board of directors of several public, private, for- and non-profit companies. He lives in California with his super beautiful, busy, and important wife, two amazing daughters, five dogs, and a menagerie of other animals.

In 2016, Howes received the College of Engineering Arbor Networks PhD Research Impact Award, an award that highlights the diverse ways in which CoE alumni have had societal impact.

GREG "JOZ" JOSWIAK: Advanced Product Marketing at Apple

Greg "Joz" Joswiak (BSE CE 1996) is Vice President of iOS, iPad, and iPhone product marketing for Apple Inc. Joz manages the product marketing and product management team responsible for many of the world's most-loved products with the highest customer satisfaction in the industry. He was recently recognized with the 2016 CoE Alumni Society Merit Award for CSE.

Joz began at Apple in 1986, just two years after the introduction of the Macintosh computer, in Apple's newly formed support organization for the Mac, and within two years, he was running that group.

His next role at Apple came when he was chosen to lead the communications function for Apple's Developer group, which supports third-party developers as they create applications for the Mac. In this capacity, it became increasingly clear that Joz had a rare blend of tech savvy and powerful communication skills – just the combination that Apple looks for in its product marketing managers – and he became a product manager for Apple's consumer and education products.

In 1997, he went on to lead product marketing for the Powerbook line – a responsibility that grew to encompass all portable products and eventually all hardware products. Over the years his responsibilities grew to include the iPod, iPhone, and iOS operating system.

In an interview Joz once said, "I was able to advance quickly at Apple, in good part because of the preparation I received at Michigan. My engineering degree provided a very good technical foundation, and the scale and culture of Michigan provided numerous opportunities for learning how to work with others and how to make better things happen as a team than you can as an individual."

KYLA MCMULLEN: Breaking Barriers in CS

Kyla McMullen (MSE CSE 2007, PhD CSE 2012) is an Assistant Professor at the University of Florida in the Department of Computer and Information Science and Engineering. Her primary research interests lie in rendering 3D audio to enhance virtual environments and to sonify information sources.

Prof. McMullen, the first African-American woman at the University of Michigan to graduate with a PhD in Computer Science and Engineering, was fascinated by computers and technology at an early age. She attributes her desire to learn computer science to her high school teacher, Mr. Randy Ware, who worked to break his students' stereotypical view of what a computer scientist looked like. This realization pushed her to continue her education in computer science after graduating high school.

McMullen decided to attend the University of Maryland for her undergraduate studies, and while there, she applied for and won a scholarship through the Meyerhoff Scholars Program. The scholars program strives to increase diversity in science, technology, engineering, and related fields, and provides community support and mentors to help students succeed.

After completing her bachelor's, McMullen made her way to U-M where she commenced her graduate studies in computer science and engineering. In 2007, while working on her Master's, McMullen began constructing educational software that taught children how to identify relationships between objects. She also worked on a research project through the Naval Submarine Medical Research Lab involving the construction of virtual environments that are navigable primarily using virtually spatialized sound cues; that work has potential applications for assistive technologies, training simulations, and workers in sight-restricted environments.

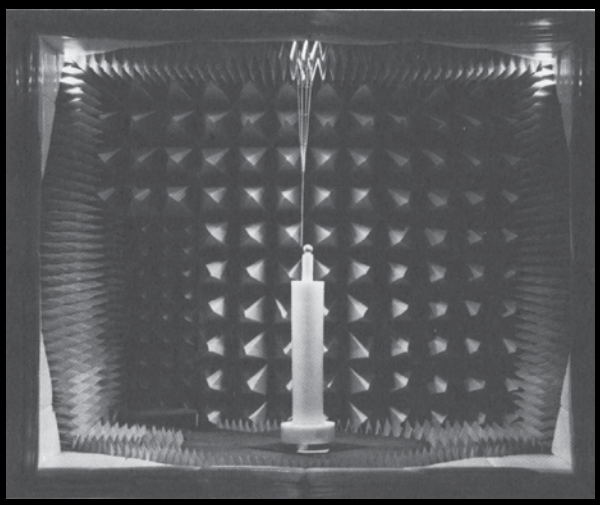
Under the guidance of her advisor, Prof. Greg Wakefield, McMullen completed her doctoral research, which focused on assessing the individualization of rendering virtual sounds over headphones. While earning her PhD she also worked as a lecturer at Wayne State University teaching computer literacy courses to over 2,000 students.

At the University of Florida, McMullen's research focuses on virtual environments, assistive technology, data sonification, and education.

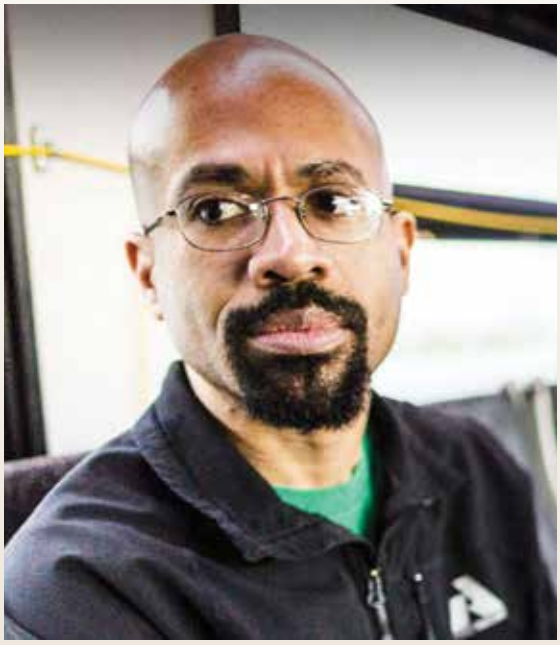
Outside of teaching, McMullen strives to increase the number of underrepresented minorities in STEM fields. She is involved in a number of organizations, including the National Society of Blacks in Computing, and makes public appearances to increase the number of underrepresented minorities in computer science.

{1958} ANECHOIC CHAMBER

Much of the research in electromagnetics during the 1950s was focused on the detection of aircraft by calculating their radar cross sections. To facilitate the research, the Radiation Laboratory built an anechoic chamber at Willow Run in 1958, believed to be only the 2nd in the United States. The chamber was used for antenna and cross section measurements, research that resulted in the Conductron Corporation. Founded in 1960 by Prof. Kip Siegel, Conductron became for a period of five years one of the largest companies in the U.S.



JAMES MICKENS: An Innovator in Academia



James Mickens (PhD CSE 2008) is an Associate Professor of Computer Science at Harvard University, where his research focuses on the security and performance of large-scale web services.

While growing up in Atlanta, Mickens recognized the importance of making connections with a diverse set of people. As one of the only black kids in his private school, he had to learn how to engage and connect with different people, and he realized that it is possible to make connections with almost anyone. As a professor, Mickens enjoys mentoring students from all backgrounds, and helping them to improve both their technical skills and the "soft" skills which are needed to make effective presentations and succeed in interviews.

Mickens received his BA in Computer Science from The Georgia Institute of Technology in 2001 and came to U-M to receive his PhD in CSE. He completed his dissertation entitled, "Exploiting Host Availability in Distributed Systems," under the guidance of Prof. Brian Noble. While at U-M, Mickens became notorious for scheduling his thesis defense in the early hours of the morning so that nobody would attend it. After graduate school, Mickens went to Microsoft Research in Redmond, WA, where he spent six years as a member of the Distributed Systems group. At MSR, he performed research, collaborated with product groups, and supervised interns who later became professors and developers at top universities and technology companies.

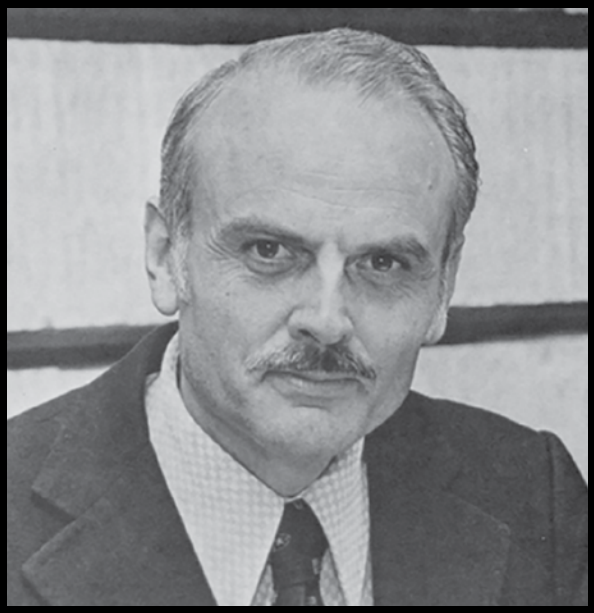
During the Fall 2014 semester, Mickens was a Visiting Professor at MIT, where he worked with the Parallel and Distributed Operating Systems group. In Fall 2015, he became an Associate Professor at Harvard.

One of his recent research projects focused on increasing the speed of web pages by using fine-grained dependency tracking. Mickens and his collaborators created Polaris, which is a dynamic client-side scheduler that uses fine-grained dependency graphs to dynamically determine which objects to load, and when.

Outside of teaching, Mickens presents at a number of conferences, including his most recent one at NDC Sydney 2016, where he talked about his life as a developer. He also plays in two heavy metal bands and writes satirical blogs about technology.

{1981} EDGAR 'TED' CODD HONORED WITH TURING AWARD

Ted Codd (MS PhD CCS 1961, 1965) received the ACM Turing Award "for his fundamental and continuing contributions to the theory and practice of database management systems." Codd invented the relational model for database management while at IBM. This transformed the entire field of database development from an ad hoc series of specialized endeavors into a respectable scientific and academic discipline.



MEERA SAMPATH: Award-Winning Corporate Innovator

Meera Sampath (PhD EE:S 1995), Vice President for Innovation and Business Transformation for Xerox, Corp., serves as the primary liaison between the company's four global labs and its services business, and oversees broad multi-industry research. This past year, she received the 2016 CoE Alumni Society Merit Award for ECE, and was honored with an Outstanding Corporate Innovator Award from Xerox.

Sampath joined Xerox in 1996 as a research scientist at the Xerox Research Center in Webster, NY. As a Principal Scientist, she led the design and development of intelligent self-diagnosing printing systems and innovative support tools for field service engineers. Later, as leader of the Xerox innovation group's emerging markets expansion team, Sampath drove the creation of the Xerox Research Center India, the company's fifth global lab and its first in Asia.

As Founding Director of the Center, she established its strategic research agenda, pioneered innovation for emerging markets, and created a strong open innovation network in India with leading academic institutions and research organizations. She clearly fulfilled the promise she showed when she received a U-M Barbour Scholarship, a highly selective award for Michigan graduate students based on their academic potential as well as their potential to contribute to their home country.

Sampath returned to campus to receive the alumni award, and delivered the talk "The Art & the Science of Innovation – Journey of a Corporate Innovator" on October 21, 2016.

"A lot of today's most challenging problems are in the emerging world."

xerox

{1953} MICROWAVES IN INDIA

Dr. Rajeswari Chatterjee (MSE PhD EE 1949 1953) brought microwave engineering to India as the first female faculty member to be hired at the Indian Institute of Science, Bangalore. After earning her PhD under William Gould Dow, she returned to India as a professor in the Department of Electrical Communication Engineering, and began teaching and research in the area of Microwave Engineering, a first for India. Chatterjee wrote seven books, mentored 20 doctoral students, wrote 100 research articles, and became Chair of the department.

UNIVERSITY OF MICHIGAN BICENTENNIAL

MICHAEL STONEBRAKER: A Leader in Database Systems

Michael Stonebraker (MSE EE 1966, PhD CICE 1971) invented many of the concepts that are used in almost all modern database management systems and founded multiple successful database companies based on his pioneering work. For this, he received the ACM A.M. Turing Award, considered the "Nobel Prize of computing," in 2014. In 2017, the College of Engineering recognized Stonebraker for his many achievements with an Alumni Society Medal Award.

Stonebraker was the main architect of the INGRES relational database management system (DBMS), and the object-relational DBMS, POSTGRES. These prototypes were developed at the University of California at Berkeley where Stonebraker was a Professor of Computer Science for twenty-five years.

Stonebraker's implementations of INGRES and POSTGRES demonstrated how to engineer database systems that support these concepts; he released these systems as open software, which allowed their widespread adoption and their code bases have been incorporated into many modern database systems. Since the pathbreaking work on INGRES and POSTGRES, Stonebraker has continued to be a thought leader in the database community and has had a number of other influential ideas including implementation techniques for column stores and scientific databases and for supporting on-line transaction processing and stream processing.

More recently at MIT, Stonebraker was a co-architect of the Aurora/Borealis stream processing engine, the C-Store column-oriented DBMS, the H-Store transaction processing engine, the SciDB array DBMS, and the Data Tamer data curation system.

Stonebraker was awarded the ACM System Software Award in 1992 for his work on INGRES. Additionally, he was awarded the first annual SIGMOD Innovation Award in 1994, and was elected to the National Academy of Engineering in 1997. He was awarded the IEEE John Von Neumann Award in 2005. He is presently an Adjunct Professor of Computer Science at MIT, where he is Co-Director of the Intel Science and Technology Center focused on big data. He also serves as Chief Technology Officer of Paradigm4 and Tamr, Inc.

ERIC VANDER WEELE: Building Bloomberg LP

Since graduating from U-M, Eric N. Vander Weele (BSE CS 2008, MS CSE 2010), has helped grow Bloomberg's technology division and increased efficiency and production for employees and clients.

Vander Weele attended U-M from 2004 to 2008 and obtained a BSE in Computer Science and a minor in Mathematics. Instead of continuing on in industry during the economic downturn, he immediately applied to U-M's graduate program to continue his studies.

In May of 2010, Vander Weele began his career with Bloomberg LP – a global finance, media, and tech company headquartered in New York City. Bloomberg's primary product, the Bloomberg Professional service (aka the Bloomberg Terminal), is a platform for clients to monitor and analyze real-time financial data, search financial news, and obtain price quotes for public and private markets globally.

From 2010 to 2014, Vander Weele developed a real-time data processing framework, which allowed developers to easily manipulate market data through a series of transformations for visual representation in the form of grids and charts. This framework was such a success that it is now integrated within the Bloomberg Terminal and is being utilized in all new projects by other teams within the company.

Due to Vander Weele's accomplishments (and a bit of luck), he and another colleague relocated to San Francisco to open Bloomberg's west coast technology hub in 2014. During the first year, he was directly involved with architects and other operational groups within Bloomberg in making decisions on the build out of the new office. He currently focuses on how to reuse and integrate existing C/C++ libraries within Python, how to improve productivity for other developers, and how to manage and monitor the deployment of Python applications. Many of Bloomberg's ~5,000 developers in engineering utilize Python, ranging from simple scripts to complicated services and applications.

Now, Vander Weele continues to push the boundaries of Python within Bloomberg while continuing to nurture his relationship with the University of Michigan, his alma mater, for attracting students to, in his opinion, one of the best technology companies to work for.

DAVID TARVER: Entrepreneur in Service to Society

David Tarver (BSE MSE EE 1975 1976) was awarded the 2017 CoE Alumni Society Service Award for his many years of service to the College and to students through his teaching on entrepreneurship.

Tarver began his career at the legendary AT&T Bell Laboratories. In 1983, he launched—in his basement with two colleagues—Telecom Analysis Systems, Inc., a high-tech telecommunications instrumentation business. He sold that company twelve years later for $30 million. Subsequently, he built a telecommunications business with a market value in excess of $2 billion. In 2012, he published the book *Proving Ground: A Memoir,* which details his entrepreneurial journey from childhood dream to international success.

Tarver currently serves as founder and President of the Urban Entrepreneurship Initiative. Its annual Symposium brings together entrepreneurs and thought leaders in business, academia, community organizations, and government.

A natural born educator, Tarver teaches in the Center for Entrepreneurship, and designed the course "Urban Entrepreneurship."

He also serves on the Electrical and Computer Engineering Council, and has served on the College's National Advisory Committee and the U-M Alumni Association's board of directors, along with several other civic and nonprofit organization boards.

In memory of his father and honor of his mother, David endowed the Fred and Louise Tarver Scholarship Fund at the College, which provides a full four-year tuition scholarship to an incoming engineering student.

During his student years, Tarver was mentored by Professor Emeritus Leo McAfee, who later consulted for his company. Tarver speaks regularly at invited events, and writes regularly for his website, DavidTarver.com.

"Change the world, and have fun doing it."

{1967} FIRST IN ENGINEERING

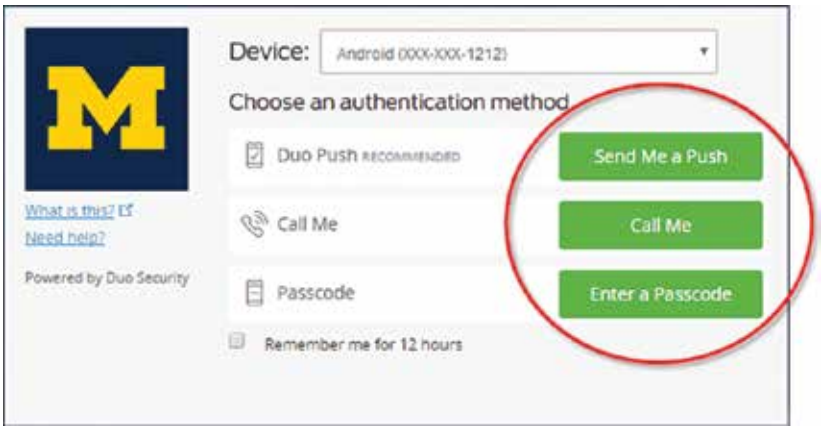
Leo McAfee (MSE PHD EE 1967 1970) made history when he became the first African American faculty member hired in the College of Engineering. McAfee influenced the lives of thousands of future engineers through his efforts in K12 outreach, and as university-wide coordinator for the Bell Labs One-Year-on-Campus graduate program. His group's work on the SECS Message Service (SMS) protocol, adopted as a standard by SEMI (Semiconductor Equipment and Materials, Inc.) in 1989, had an important impact on semiconductor factory automation.

Duo Security Provides Two-Factor Authentication at U-M

In 2016, the University of Michigan started taking steps to increase the protection of sensitive data by expanding the use of two-factor authentication. This included switching from physical MTokens, the university's previous two-factor authentication solution, to Duo Security's more flexible two-factor authentication.

Ann Arbor-based Duo Security, founded CSE alumni Jon Oberheide (CSE PhD 2011) and Dug Song (CS BS 1997), has been making waves in the security field since it launched in 2009, and securing the University of Michigan as a client shows the extent to which the company has grown.

Duo Security's product enables users to secure their logins and transactions, and the Duo two-factor authentication provides a second layer of security, keeping an individual's account secure even if their password is compromised. Duo operates using an app that pushes a notification to a smartphone or mobile device for approval when logging in to protected systems. Other Duo options include a receiving a phone call, passcodes sent via text message, and Duo hardware tokens.



The transition from MTokens to Duo two-factor authentication started July 20, 2016 and is currently in use for Wolverine Access, FLUX, DART, and some departmental systems.

Duo Security has experienced exponential growth in the last few years. In 2015, the company launched a new platform that allows administrators to see who is logging in to an enterprise network and where they are logging in from. Clients are also able to decide who has access to networks and they are able to shut down logins that are suspicious.

In April 2016, Duo received a $2.5 million grant from the State of Michigan which will support their mission to add around 300 jobs. As a result, they have opened a second office in Ann Arbor with hopes to create the 300 jobs within the next couple of years.

The company currently has offices in London, Austin, and San Mateo and will continue to expand operations worldwide.

Founded by CS Alums, Cribspot Evolves Into Rental Property Management Company

Cribspot, an Ann Arbor-based company founded by Tim Jones (BSE CS 2013), Evan Dancer (BSE CS 2013), and Jason Okrasinski, a former Ross Business student, has used CS to manage student rentals since its inception in 2013.

Cribspot founders, pictured in 2013.

The company began as a student project called a2cribs.com in November 2012, and then relaunched as the startup cribspot.com in March 2013. At first, Cribspot was a simple rental platform that made searching local sublets, then rentals, easy by bringing together thousands of listings on one searchable map, but the company quickly grew to become a full-service property management company.

Cribspot now handles around 850 clients, where they work with property owners to market, lease, and maintain properties, and they have expanded to open offices in two other college towns: East Lansing, MI and Columbus, OH. They plan on expanding to even more locations in the future.

The alums are also focusing on delivering a good user experience with their website by providing virtual tours for their properties, providing tenants with online leases, and providing a mobile app that tenants can use to communicate with Cribspot employees.

The artificial intelligence that is integrated in the mobile app allows property owners to have a more hands-off experience while Cribspot can field questions and concerns and provide automated responses when possible.

The founders hope to grow their startup to reach 2,500 to 3,000 tenants by the end of 2017.

Most of these updates are taken from online news stories. Send your updates directly to us at:
http://www.eecs.umich.edu/ece/alumni-updates.html

1970's

Kevin Johnson (BSE EE 1979) received the IEEE-USA Award for Distinguished Public Service "for sustained leadership in furthering reform of noncompete agreements in employment contracts." Kevin is working along with the New England Venture Capital Association on legislation to help employees and the Massachusetts economy by banning noncompete agreements. He says that these agreements reduce Massachusetts employee job mobility and income. A *New York Times* article about his work says that nearly one fifth of the nation's workforce "are hobbled by so-called noncompete agreements." With his MBA from Harvard, Johnson has worked at several tech companies in sales, and founded three companies. The most recent is called Common Commute, which he says "makes commute sharing stupid simple."

1980's

Kukjin Chun (MSE PhD EE 1981 1986) was honored by the President of South Korea with the Order of Science and Technology Merit, the highest national honor for a Korean scientist and engineer. This Order of Merit is awarded to those who have rendered outstanding meritorious services in the interest of improving science and technology. The Order of Merit recognizes Kukjin's distinguished career in the MEMS field. In particular, he is known for his work with Korean industry to develop a transceiver with MEMS switches, contributing to the commercialization of fourth generation telecommunication (4G). Kukjin Chun is professor of Electrical and Computer Engineering at Seoul National University (SNU), where he served as department head from 2009-2011.

Prof. Kukjin Chun, from the Seoul National University, receives the South Korea Order of Science and Technology Merit from Interim Korean President and Prime Minister Hwang Kyo-ahn.

1980's

Dennis Grimard (MSE PhD EE 1984 1990) delivered the commencement address at his undergraduate alma mater, Vermont Technical College. A Vermont native and former Director of the University of Michigan Lurie Nanofabrication Facitliy (LNF), Grimard contributed greatly to the construction of Michigan's LNF. He is currently Acting Managing Director of MIT's new nanofabrication lab (MIT.nano), which he helped plan and implement. During his address, Grimard said, "Don't be afraid of world-changing challenges," as the solutions may come when you least expect it.

Suresh Subramanian (MSE PhD CSE 1986 1988) leads Global Industry Relations at iconectiv, where he is responsible for managing and leveraging the company's extensive global relationships with regulators, service providers, and industry associations. Prior to iconectiv, he was a Senior Vice-President at Telcordia, leading Global Consulting and Sales with a focus on the most appropriate strategies required by organizations to capitalize on regulatory, market, and technology disruptions in the telecom space. His daughter Sita is currently a Senior in the BBA Program at Ross, ensuring that the Wolverine spirit is passed on to the next generation... Go Blue!

1990's

Michelle Stock (BSE MSE PhD EE 1988 1990 1994) has been elected Fellow of SPIE, the International Society for Optics and Photonics, "for achievements in business development and science policy for the photonics industry." Dr. Stock is President of mlstock consulting and also leads Mi-Light, the Michigan Photonics Industry Cluster. Mi-Light serves as the focal point for supporting, promoting, and growing the photonics industry in Michigan.

Jon Allen (BSE EE 1992) reached Quarter Century status at IBM. His whole career has been in hardware development engineering at the IBM site in Rochester, MN. He has eight U.S. patents, which include a method of testing of motherboard hot-plug circuits and a design for a wearable laptop lock cable.

1990's

Dave Carter (BSE EE 1993; MILS 1995 School of Information) opened the Computer and Video Game Archive in 2008 to collect and preserve video games, and the 10-year project has now gathered over 7000 titles. The games are open to all, and visitors can play on everything from an Atari or a Commodore 64 to a Playstation 4 or an Xbox 360. Carter serves as a reference services librarian and CVGA archivist.

Brian Hernacki (BSE CE 1995) is Vice President of Software Engineering at Intel Corporation in Santa Clara, CA, designing and developing cutting-edge wearable technologies. Before joining Intel, he was Chief Architect at Palm where he helped design and develop WebOS and the Palm/HP Touchpad. His first job after graduating from Michigan was at Netscape, the leading Internet browser company in the mid 1990s. He's worked at startups and large companies alike in Silicon Valley, often specializing in information security. He co-authored the book, *Testing Network Security: Evaluating Intrusion Detection and Prevention Systems,* with Jeremy Bennett, another Michigan alumnus.

Brian lives in Silicon Valley. He says, "I continue to love to work on exciting new technologies and am always on the lookout for promising young Michigan graduates."

Vishal Giare (MS EE:S and Physics 1997) has been named mission area executive for Air and Missile Defense at The Johns Hopkins University Applied Physics Laboratory (APL). Giare has more than 20 years of experience in the design, development, testing, and evaluation of advanced missile defense systems. He most recently served as APL's program area manager for Aegis Ballistic Missile Defense (BMD). Before that he contributed to and led development of BMD sensor, command and control and weapon systems and served as a trusted agent and technical advisor to senior U.S. Navy and Missile Defense Agency leaders. Giare also holds an Executive Education Certificate from Harvard Kennedy School.

Babak Parviz (MSE PhD EE 1997 2001; MS Physics 1997), VP at Amazon, was one of 10 U-M alumni honored with a University of Michigan Bicentennial Alumni Award at the spring commencement, "For his pioneering technological innovations that augment human potential, and thus improve peoples' lives." Parviz is the creator of Google Glass, and former director at Google X. After studying MEMS at Michigan, he completed a postdoctoral fellowship at Harvard University in chemistry and chemical biology, and joined the Department of Electrical Engineering at the University of Washington. In 2010, two years after developing a bionic contact lens prototype, he joined Google, where he initiated and led the Glass project until 2013. He also founded Google's robotics surgery initiative, which became Verb Surgical, an independent company, and co-founded Google's Smart Contact Lens program. Parviz joined Amazon in 2014, and, in 2015, was elected a SPIE fellow by the International Society for Optics and Photonics.

Dr. Peter Wurman (MSE ME 1988, MS CSE 1996, PhD CSE 1999) has joined Cogitai, the artificial intelligence start-up focused on next-generation machine learning technologies, as Vice President of Engineering. In this role, Dr. Wurman will be in charge of overseeing Cogitai's engineering operations and project planning.

2000's

Vashist Vasanthakumar (BSE MSE EE 2005 2007) is founder and CEO of Vaya Life (vayalife.com). He started the company with the goal of reinventing traditional and widely used personal products, starting with one of the most versatile products — the lunchbox. Formerly director of operations at Apple, Vasanthakumar and his team spent 18 months fine-tuning and perfecting their first product after testing with 60 prototypes. Since shipping began in October 2016, Vaya's lunchboxes have become popular in Malaysia, Singapore, France, Germany, and America. "We had no plans of launching abroad, but after many requests we launched a website and now ship to eight countries. Twenty percent of our sales comes from abroad. Who knew lunchboxes were not only an Indian concept!" he laughs. [from the article by Abinaya Kalyanasundaram in *The New Indian Express*.]

Raj Vable (BSE EE 2009) is founder of Young Mountain Tea, a company he started in 2013 to create sustainable livelihoods for rural communities in the Kumaon region of India, resting in the foothills of the Himalayas. He first discovered this area while there on a Fulbright Fellowship, working to create dignified rural livelihoods. The company buys teas from the Kumaon producers, exports them to the United States and then sells the tea to local customers. The team has grown to five, including Vable and his partner, Jeff Aspinall, a business major he met at Michigan.

Young Mountain Tea plans to launch the Global Tea Exchange September 26, 2017. Learn more at youngmountaintea.com.

Samantha Luber (BSE CE 2012) graduated from the University of Southern California with a MS in Computer Science, and has started a job at Native Instruments as a C++ Engineer for their iMaschine and Traktor DJ products.

Jim Boerkoel (CSE MS 2008, PhD 2012), Assistant Professor in the Computer Science Department at Harvey Mudd College, was awarded an NSF Faculty Early Career Development (CAREER) grant for his project "Robust and Reliable Multiagent Scheduling Under Uncertainty." The research conducted under the grant will improve robustness and reliability in applications such as autonomous driving, automated warehousing, and personal robots by addressing fundamental limitations in how current planning systems handle real-world scheduling uncertainty.

Vahed Qazvinian (PhD CSE 2012) co-founded and is the CTO of Mystacks, Inc., which is a simple, cloud-based platform that allows you to draft groups of documents simultaneously. The company also launched Lawyaw, a platform that enables lawyers to populate, edit, and sign Judicial Council and court forms.

Azadeh Ansari (MSE PHD EE 2013 2016) received a 2017 ProQuest Distinguished Dissertation Award for her dissertation, GaN Integrated Microsystems for RF Applications. This award recognizes exceptional dissertations of outstanding scholarly quality in any field of study. The focus of her dissertation was the design, fabrication, and characterization of novel and advanced electroacoustic devices and integrated micro/nano systems based on Gallium Nitride (GaN). GaN is the material that led to the development of new high-efficiency lighting and was the focus of the Nobel Prize in Physics in 2014.

Dr. Ansari's research has resulted in the highest reported resonance frequencies and (fxQ) values in GaN bulk-mode devices to date. Such high-performance integrated systems can be utilized in radio frequency (RF) and microwave communication as well as extreme environment applications. And she achieved this on silicon, which enables easier integration with modern high-performance electronics. Her research resulted in one issued patent, and another two provisional patents. Dr. Ansari was a postdoctoral scholar in Physics at CalTech this past year before joining the faculty at Georgia Tech as an Assistant Professor in September 2017.

Tara Safavi (BS CS 2017) was selected as a recipient of the Google Women Techmakers Scholarship to continue her studies in computer science and engineering. Tara's research interests are in data mining on large graphs. Her most recent project was her honors thesis, which was about scaling the process of constructing brain networks out of fMRI data, a major subject of interest in neuroscience. This summer she is an intern at Google, where she is doing data mining to help operate Google's network.

Russell Ladd (BSE CS 2017) is going to work for Apple as a software engineer. He says, "I'm excited to start working for Apple in software engineering! I'll never forget all the friends and memories I made with Michigan Hackers and MHacks, and I look forward to giving back to those communities in the future."

Xploring *EECS* Engineering

The fifth annual College of Engineering Xplore Engineering camp introduced the families of alumni to the joy of engineering through a variety of hands-on experiences. EECS-led camps covered a variety of physical and computing topics.

Filling in the Blanks

A team of CSE graduate students introduced attendees to computational linguistics – the intersection of computer science and linguistics – and helped them to solve puzzles, build chatbots, and explore how computers process language.

Light, Pinholes, and Lenses! Camera and Computer Imaging

Prof. Jason Corso's workshop showed visitors how cameras combine new and old technology, the basics of light and image formation and distortion, and how to build their own camera out of a coffee cup.

Solar Solutions: Harnessing the Sun's Energy

Attendees of Prof. P.C. Ku's sessions got an inside look at how solar cells harness the sun's energy. Families made their own solar concentrators by cutting and folding CDs like origami.

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David Tarver
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Vik Verma
CEO, 8x8, Inc.

Dawson Yee
Principal H/W System Architect & Engineer, Devices and Studios Group, Microsoft

Peter and Evelyn Fuss Endowed Chair of Electrical and Computer Engineering

Peter and Evelyn Fuss created a Michigan ECE legacy by endowing the Peter and Evelyn Fuss Chair of Electrical and Computer Engineering. Believing in the power of creativity and quick action, Peter and Evelyn want to give the department maximum flexibility to respond to new initiatives and special needs wherever and whenever they arise. They are especially interested in expanding student diversity.

Peter Fuss (BSE EE 1956) is the former President of Tellabs International, Inc., which he established in 1987 as a subsidiary of Tellabs, Inc. Tellabs International is responsible for all Tellabs operations outside of North America. Tellabs, Inc. is a leading international manufacturer of voice and data communication equipment. Evelyn Fuss is a graduate of Mount Holyoke College. Evelyn and Peter met while attending a local postgraduate young people's group in NJ. Evelyn worked at the company between 1960-1963, doing subjective testing of dial tones.

"On behalf of the students and the entire Electrical and Computer Engineering community, I would like to convey my deepest gratitude for this gift," said Khalil Najafi. "I am proud to be the first to bear the name of the Peter and Evelyn Fuss Chair of Electrical and Computer Engineering."

This gift is Peter and Evelyn's latest in an active relationship with Peter's alma mater. Peter and Evelyn provided a leadership gift for the construction of the Peter S. Fuss Pavilion on North Campus, and they endowed the Peter S. Fuss Professorship of Engineering (previously held by Duncan Steel). Peter served on the EECS National Advisory Committee, and was a member of the Engineering Alumni Society Board of Governors. He served as Chair of the Michigan Engineering Fund in 2000, and was a member of the 150th Anniversary Campaign Committee from 2000-2008. He received the 1995 Alumni Society Merit Award for EECS, and the College of Engineering Alumni Society Medal in 2011.

Peter and Evelyn Fuss were presented with a football signed by Coach Jim Harbaugh as a small token of appreciation during a recent visit to campus.

Forrest Family Supports UG and Grad Engineering Students With Three New Funds

Prof. Stephen R. Forrest (MS PhD Physics 1974 1979) and Rosamund M. Forrest (AM LS 1978), have established two funds to support graduate students in the fields of sustainability and energy. They are named the Stephen and Rosamund Forrest Graduate Student Fellowship Fund in Energy and Sustainability, and the Gerald and Esther Forrest Graduate Student Fellowship in Energy and Sustainability.

In addition, the Stephen and Rosamund Forrest Family Foundation have established the Forrest Family Endowed Engineering Scholarship Fund in the College of Engineering to provide need-based support to undergraduate students.

After working at USC and Princeton University, Dr. Forrest joined the University of Michigan as the Vice President for Research in 2006, and is currently the Paul G. Goebel Professor in Electrical Engineering and the Peter A. Franken Distinguished University Professor of Engineering. Among his many awards for academic and research achievements, Dr. Forrest is a fellow of the APS, IEEE, and OSA. He is a member of the National Academy of Engineering, National Academy of Sciences, and National Academy of Inventors.

Lattice Data Makes Gift to Michigan Computer Science and Engineering Fund

Lattice Data, Inc. has made a gift to supplement the CSE Special Projects Fund, an endowment that supports student projects, special instructional needs, seminars, and special visitors to the division and other activities related to the mission of the division.

Located in Menlo Park, California, Lattice Data is a data intelligence company that transforms "dark data," such as unstructured text and images, into high quality structured data for use by traditional data analysis tools. Lattice Data was co-founded by Prof. Michael Cafarella, Stanford Prof. Christopher Ré, and Feng Niu.

D'Souzas Make Gift to Support Undergraduate Students in CSE

Robin (BSE CS 2006) and Priancka D'Souza of New York City have established the Robin and Priancka D'Souza Family Scholarship to provide need-based support to undergraduate students pursuing a degree in computer science.

Robin is a Team Lead in the Engineering Department at Bloomberg. He holds an MBA in Entrepreneurship, Strategy & Change Management from New York University's Leonard N. Stern School of Business.

Priancka is in Risk Management at JPMorgan Chase. She holds a BS in CSE from University of Pennsylvania and an MBA in Finance from New York University's Leonard N. Stern School of Business.

Mount and Wu Scholarship Rewards Extracurriculars

Brian Mount (BSE CE 2001, MSE CSE 2003), Melissa Wu (BSE CIV 2003), and Michelle Wu (BSE ChE 2001) have endowed the Mount and Wu Families Scholarship. This fund will provide need-based support for in-state, undergraduate students with a preference for those engaged in College of Engineering extracurricular activities.

Melissa Wu and Brian Mount reside in Seattle, WA with their two daughters. Melissa is a wastewater engineer and project manager at CH2M HILL where she focuses on the development of wastewater infrastructure in the Pacific Northwest. Brian is a Principal Software Engineering Manager at Microsoft in Windows Experiences, most recently responsible for multiple HoloLens launch applications.

Michelle Wu is the Vice President of Quality at Ximedica, a contract product development firm exclusively focused on the development and manufacture of medical devices and technologies, located in Providence, RI.

{2005} BREAKING GROUND FOR THE FUTURE

Ann Lurie (3rd from the left) at the groundbreaking ceremony of the Lurie Nanofabrication Facility (LNF) with key LNF donors Jerry Levin (BSE EE and Eng. Math 1966 1967) and Donald C. Graham. Also pictured are Khalil Najafi, former CoE Dean Stephen Director, and former EECS Chair David C. Munson, Jr.

Ann Lurie has been a long-time supporter of the research of Prof. Ken Wise's work impacting hearing for the deaf and neural implants for medical applications. She led the fundraising effort for the Robert H. Lurie Nanofabrication Facility with a gift of $15M, named in memory of her husband, Robert H. Lurie (1942-1990). Other key donors to the facility include: Vincent T. and Gloria M. Gorguze, Donald C. Graham, C. Robert Kidder, and Ford Motor Company.

UNIVERSITY OF MICHIGAN BICENTENNIAL

Thanks to our Donors

The Department thanks the donors named below as well as those who gave anonymously since 2016. 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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Ackerman, Mark S.
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CSE, SI

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ECE

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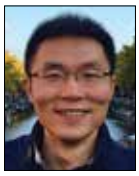

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Nees, John
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ECE

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ECE

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AP – Applied Physics
BioPHY – BioPhysics
BME – Biomedical Engineering
CEE – Civil and Environmental Engineering
ChemE – Chemical Engineering
CLASP – Climate and Space Sciences and Engineering
CSE – Computer Science and Engineering
CMB – Computational Medicine and Bioinformatics
ECE – Electrical and Computer Engineering
EEB – Ecology and Evolutionary Biology
IntMed – Internal Medicine
IOE – Industrial and Operations Engineering
IOG – Institute of Gerontology
LING – Linguistics
Macro – Macromolecular Science and Engineering
MATH – Mathematics
ME – Mechanical Engineering
MSE – Materials Science and Engineering
NAME – Naval Architecture and Marine Engineering
NERS – Nuclear Engineering and Radiological Sciences
OTO – Otolaryngology
PHIL – Philosophy
PHY – Physics
PSYCH – Psychology
RAD – Radiology
SI – School of Information
SOE – School of Education
STATS – Statistics
UMTRI – University of Michigan Transportation Research Institute

Michigan EECS: Where Progress Never Stops

{1884}

First course offered in"Electrical Measurements" by Henry Smith Carhart in the Physics Department

{1905}

Department of Electrical Engineering established in the College of Engineering. It was one of three departments that formed the original College of Engineering that same year

{1945}

Michigan Aeronautical Research Center, which became known as **Willow Run Laboratories**, established by William Gould Dow and Emerson W. Conlon of Aeronautical Engineering

{1889}

Undergraduate program in **Electrical Engineering established** in LSA

{1931}

Michigan the **first** to require an **electronics course** in its curriculum. It was called, "Electronics and Vacuum Tubes"

{1947}

Electrical Engineering Department finds a home in East Engineering

{1999}

Arthur Burks, Bob Axelrod, Michael Cohen, and John Holland (known as the BACH group) established the **Center for Complex Systems**

{2000}

Undergraduate program in **Computer Science** established in CoE

{2006}

New CSE Building dedicated; renamed Bob and Betty Beyster Building in 2012

{2008}

Dedication of the **Lurie Nanofabrication Facility**; directed by Ken Wise, William Gould Dow Distinguished University Professor

{2008}

Office of Research Cyberinfrastructure established, directed by Daniel E. Atkins. Renamed Advanced Research Computing in 2013

{2009}

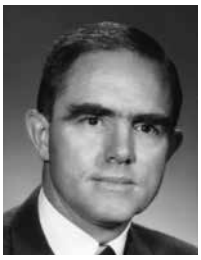
Michigan Institute for Plasma Science and Engineering established, directed by Mark Kushner, George I. Haddad Professor of EECS

{2015}

Undergraduate program in **Data Science** established

UNIVERSITY OF MICHIGAN BICENTENNIAL

{1952}



First course in computers offered: "Seminar in Computer Technology" under the direction of Norman R. Scott with J. DeTurk and L.E. Kolderup of the Willow Run Research Center

{1961}

Undergraduate program in Communications Science established in LSA; this later became the CCS and then the CS-LSA program

{1962}

The graduate program in **Bioengineering** initiated within the EE Department

{1968}

Graduate program in **Computer, Information, and Control Engineering (CICE)** established in CoE

{1957}

Graduate program in Communication Sciences established in LSA by Arthur Burks and Gordon Peterson

{1964}

Department of Communication Sciences is established in LSA; renamed Computer and Communication Sciences (CCS) in 1968

{1971}

Undergraduate program in **Computer Engineering** established

{1971}

Department of Electrical Engineering changed to the **Department of Electrical and Computer Engineering**

{1996}

School of Information chartered by Regents; first dean was Daniel E. Atkins

{1986}

Dedication of the Electrical Engineering and Computer Science Building

{1984}

Department of Electrical Engineering and Computer Science formed in CoE from the Department of Electrical and Computer Engineering, the Department of Computer and Communication Sciences, and the graduate program in CICE

{1996}

Charles Cain (PHD EE 1972) named **first Chair** of the **Department of Biomedical Engineering**

{2015}

Michigan Institute for Data Science established, directed by Alfred O. Hero, Jr., R. Jamison and Betty Williams Professor of Engineering

{2016}

Michigan Robotics established, directed by Jessy Grizzle, Elmer G. Gilbert Distinguished University Professor and Jerry W. and Carol L. Levin Professor of Engineering

{2017}

EECS faculty and students about to **change the future – again!**

ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
UNIVERSITY OF MICHIGAN

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EECS History Quiz

As the University celebrates its bicentennial, EECS is celebrating its own history. See how many of these questions you can answer!

1. Who said they did all their studying by the light of a kerosene lamp?
2. Who beat Thomas Edison to install the first electric light system in the U.S.?
3. What year did the University first establish a computing center?
4. Whose lab was protected by the Nuclear Saints of America?
5. What year was the first African American faculty hired in the College of Engineering?
6. Who worked on the very first programmable computer, called the ENIAC?
7. Whose work in database systems earned him a Turing Award?
8. What was the name of the first multiprocessing terminal-based system at Michigan?
9. Which research center spawned bladeless Lasik surgery?
10. What was the specialty of the first female hired at Honeywell?
11. When did Claude Shannon graduate from the University of Michigan?
12. What image was featured in the very first hologram?
13. In what year did alumnus Larry Page create Google?
14. Who created Michigan's first official mobile app?
15. What did it mean to CRISP?
16. What year was the first PhD in CS issued?
17. What was the name of the first database of academic journals?
18. What year was the Computer Science undergraduate program established in the College of Engineering?

Find the answers on these pages: 1) p.3 2) p.31 3) p.66 4) p.43 5) p.93 6) p.9 7) p.90 8) p.18 9) p.4 10) p.83 11) p.50 12) p.24 13) p.35 14) p.69 15) p.64 16) p.40 17) p.58 18) p.110