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Michigan
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Electrical and Computer Engineering
Annual Report 2016

ECE

Optimization and Control
of Tomorrow's Electrical Grids



Hello to all our good friends from the faculty, staff, and students of the Department of Electrical and Computer Engineering at Michigan Technological University. It is an honor and a pleasure to share with you another annual report, covering the many activities and accomplishments in the ECE Department in the latest reporting period, which runs from July 1, 2015 to June 30, 2016.

First things first—the weather, everyone’s favorite subject in the Upper Peninsula. It was an

absolutely fabulous summer in Houghton, with more sunny days in the 70s than I can remember in many years. I was fortunate enough to stay close to home and enjoy most of those days myself, often on a bicycle, boat, or running trail. If it stayed like this all the time, none of us could afford to live here!

I am happy to report that the ECE Department is thriving. Our undergraduate enrollment remains strong, with a 23 percent increase in new freshmen this year and the highest total undergraduate enrollment we have seen since 2008. Our MS program has doubled in size over the past 10 years. Our research expenditures have nearly doubled over the past three years and have returned to 2011 levels, turning the corner on a pretty serious decline. One of the most heartening aspects of that last statistic is the number of ECE faculty members contributing to our research mission: some 17 out of the 25 full-time equivalent faculty members had externally sponsored research programs this past year.

We have a number of articles in these pages describing the research activity in further detail. This year, I want to draw your attention to the continued strong presence of ECE in the power and energy arena, as featured on the cover. This has been an area of strength for ECE ever since our founding in 1928, and it is an area of critical national concern, as most of you know. Most of the growth of the MS program, mentioned in the paragraph above, comes from students with an interest in power and energy, and this has led to almost unmanageably large class sizes; that’s a good problem to have. The area is hot among our undergraduates, too, who are highly recruited in the utility power and consulting industries. We have profiled several power faculty in previous reports, and this year we feature the work of Sumit Paudyal, who has been with us for four years and is making major contributions in power system operations and optimization.

In our undergraduate programs we continue to stress breadth in the fundamentals, individual skills, and team-based design experiences. One of our very best instructors, someone who exemplifies everything we are trying to do in undergraduate education and is profiled in this report, is our HKN Professor of the Year, Senior Lecturer Kit Cischke. Kit is a stalwart in our sophomore and junior computer engineering courses, and is the faculty mentor for the Wireless Communication Enterprise. Our computer engineering program would not be what it is without his tireless efforts. (And, just to prove how tireless he is, Kit bicycles to work in the snow.)

Our approach to undergraduate education continues to pay off at recruiting time for our students. Last September at our fall Career Fair there were 370 companies and organizations on campus looking to



hire Michigan Tech students, and fully two-thirds of them were looking for EEs and CpEs, among others. I hear anecdotal evidence of starting salaries over \$70k. At this time of economic uncertainty and mounting college debt for so many Americans, it's a good time to be a graduating senior in engineering.

This year marks the first year of operation for the Institute of Computing and Cybersystems (ICC), the research arm of the Alliance for Computing, Information, and Automation, which brings together the ECE Department, the Department of Computer Science, and the School of Technology.

On a personal note, I have been in this position for eight years, loving every minute, and this past year I went through a review process and was reappointed for another three-year term beginning in 2017. I'll be around for at least another four years. I am looking forward to seeing the fruits of the investments made in recent years, and to thinking about what we need to be doing to support the mission of Michigan Tech as it goes through its own long-term strategic planning process. I can't wait. If you have any thoughts along those lines, please feel free to share them—as always, I would love to hear from you.

Daniel R. Fuhrmann
Dave House Professor and Chair
Department of Electrical and Computer Engineering
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On the cover: Sumit Paudyal and his research team are developing real-time and efficient control algorithms to aggregate distributed energy resources and coordinate them with the control of the underlying power grid infrastructure. Read more on page 11.



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ECE FACULTY DIRECTORY

Ashok Ambardar

Associate Professor
PhD, Electrical Engineering, University of Wyoming
Signal processing, medical imaging

Glen Archer

Principal Lecturer/Associate Chair
PhD, Electrical Engineering,
Michigan Technological University
Image processing, security, information operations

Paul Bergstrom

Professor
PhD, Electrical Engineering, University of Michigan
MEMS, nanotechnology

Leonard Bohmann

Professor/Associate Dean, College of Engineering
PhD, Electrical Engineering, University of Wisconsin
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Jeremy Bos

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Atmosphere optics, image processing, machine intelligence

Duane Bucheger

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Signal processing, power electronics

Jeffrey Burl

Associate Professor
PhD, Electrical Engineering,
University of California–Irvine
Adaptive control, robust control, image motion estimation

Bo Chen

Dave House Associate Professor of Mechanical
Engineering and Electrical Engineering
PhD, Mechanical and Aeronautical Engineering,
University of California–Davis
Intelligent mechatronics, embedded systems

Christopher (Kit) Cischke

Senior Lecturer
MS, Computer Engineering, University of Minnesota
Parallel computing and UPC

Zhuo Feng

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PhD, Computer Engineering, Texas A&M University
VLSI computer-aided design, multiphysics modeling
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Daniel Fuhrmann

Dave House Professor and Chair
PhD, Electrical Engineering and Computer Science,
Princeton University
Statistical signal and image processing

Lucia Gauchia

Richard and Elizabeth Henes Assistant Professor of Energy Storage Systems
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Energy storage systems, state estimation for batteries and supercapacitors

Durdu Guney

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PhD, Electrical and Computer Engineering, University of California–San Diego
Metamaterials and plasmonics, quantum computing, communications and cryptography

Timothy Havens

William and Gloria Jackson Associate Professor
PhD, Electrical and Computer Engineering, University of Missouri
Pattern recognition and machine learning, signal and image processing

Shiyan Hu

Associate Professor
PhD, Computer Engineering, Texas A&M University
Computer-aided design of VLSI circuits and combinatorial optimizations

Roger Kieckhafer

Associate Professor
PhD, Electrical Engineering, Cornell University
Computer architecture, fault-tolerant computing

John Lukowski

Associate Professor
Chair, Undergraduate Program Committee
MS, Electrical Engineering, Michigan Technological University
Power, energy, factory automation, robotics

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Infrared detectors, optics, photonics, radiometry

Bruce Mork

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Power system transients (ATP/EMTP), nonlinear dynamics and chaos theory, power system protection

Saeid Nooshabadi

Professor
PhD, Integrated Circuits (VLSI), Indian Institute of Technology Delhi
High-performance computer architecture, embedded systems

Aurenice Oliveira

Associate Professor
PhD, Electrical Engineering, University of Maryland, Baltimore County
Optical fiber communications, automation, wireless communication

Sumit Paudyal

Assistant Professor
PhD, Electrical Engineering, University of Waterloo, Canada
Smart-grid technologies, optimization techniques in power systems

Joshua Pearce

Associate Professor
PhD, Materials (Engineering option)
The Pennsylvania State University
Photovoltaic materials and devices, energy system analysis and policy, 3-D printing and additive manufacturing

Warren Perger

Professor
PhD, Physics, Colorado State University
Theoretical atomic physics, electrophysics

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PhD, Electro-Optics, Air Force Institute of Technology
Optics, image reconstruction and processing, pattern recognition

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Power electronics systems, microgrids, hybrid and electric vehicles

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Professor
PhD, Communication, Colorado State University
Wireless localization systems, wireless power transfer, statistical signal processing

FACULTY HIGHLIGHTS

Promotion and Tenure

Durdu Guney, Timothy Havens, and Chee-Wooi Ten were promoted from assistant professor to associate professor with tenure. The ECE Department congratulates Professors Guney, Havens, and Ten on this accomplishment, and on all their achievements in research and teaching.



Awards

Glen Archer received Institute of Electrical and Electronics Engineers (IEEE) grade advancement to Senior Member in recognition of his accomplishments in the field of electrical engineering.

Bo Chen and her student Shreyash Joshi received Best Student Paper at the 2015 ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications (MESA2015), Boston, Massachusetts, August 2015, for Modeling and Hardware-In-the-Loop Simulation of Power-Split Device for Hybrid Electric Vehicles.

Kit Cischke was honored as Professor of the Year presented by the Michigan Tech chapter of Eta Kappa Nu (HKN), the student honor society of IEEE. He was selected by a vote of ECE students for all-around excellence in teaching.

Durdu Guney was awarded Elsevier Recognized Reviewer status for the journals *Photonics and Nanostructures - Fundamentals and Applications* and *Physics Letters A*.

Trevor Hassell received a Professional Engineering License from the State of Michigan.

Aurenice Oliveira received IEEE grade advancement to Senior Member in recognition of her accomplishments in the field of communications.

Joshua Pearce received the Silver Quill Award from Brigadier General Anthony Funkhouser, commander of the Northwestern Division, U.S. Army Corps of Engineers and also an Emerging Contributor Award at Opensource.com.

Zhaohui Wang received the Outstanding Service Award for her work as Information Systems Chair in the 10th ACM International Conference on Underwater Networks & Systems (WUWNNet), held in Washington, DC.

Professional Service

Glen Archer served as a reviewer for the Department of Defense SMART scholarships. He was also appointed to serve as an ABET EAC evaluator.

Paul Bergstrom is serving as faculty fellow for strategic planning and budget in the Vice President for Research Office at Michigan Tech for the 2015-16 and 2016-17 academic years. His focus is on the development of Michigan Tech's Core Facilities framework.

Leonard Bohmann was elected treasurer of the IEEE Education Society and serves on the Board of Governors. He was also appointed to the Engineering Accreditation Commission of ABET.

Jeremy Bos was appointed for a third consecutive year to serve on SPIE's Scholarship Committee. Jeremy started a session at the IEEE Aerospace Conference on "Optical Detection and Analysis for Space Situational Awareness (SSA)" and helped to organize a conference on Long Range Imaging at the SPIE Defense and Commercial Sensing Symposium.

Lucia Gauchia serves as associate editor of *IEEE Transactions on Transportation Electrification*.

Durdu Guney serves on the editorial board of *Nanomaterials and Nanotechnology* as associate editor for *Nanodevices*. He also served as Session Chair and Jury Member for the Best Student Paper Award at SPIE Optics + Photonics, August 2015, San Diego, California.

Tim Havens is an associate editor of *IEEE Transactions on Fuzzy Systems* and is the lead guest editor for the special issue of *Advances in Fuzzy Systems on Fuzzy Fusion of Sensors, Data, and Information*.

Shiyan Hu serves as chair for the IEEE Technical Committee on Cyber-Physical Systems. He serves as associate editor for *IEEE Transactions on Computer-Aided Design, IEEE Transactions on Industrial Informatics, and IEEE Transactions on Circuits and Systems*. He also serves as guest editor for *IEEE Transactions on Computers and IEEE Transactions on Big Data*. He is TPC co-chair for IEEE CPSDA and CPSS in 2016.

Chris Middlebrook was made senior member of the OSA (Optical Society of America) and appointed to the Technical Committee and the SPIE Photonics West Optical Interconnections Committee.

Bruce Mork is chair of the IEEE Transmission & Distribution Committee Working Group on Ferroresonance in Power Systems, and chair of the IEEE Transmission & Distribution Committee Working Group for Power Globe.

Aurenice Oliveira was appointed to serve as ABET EAC evaluator and serves on the editorial board of the *International Journal of Engineering Research and Innovations (IJERI)*.

Joshua Pearce is the founding editor and editor in chief of *HardwareX*, which is a new Elsevier open access journal established to promote free and open source designing, building, and customizing of scientific infrastructure (hardware). He also serves on the Sustainable Energy Technologies and Assessments Editorial Board and the Materials Editorial Board, where he was a guest editor on a special issue of *Solar Photovoltaic Materials*. In addition, Pearce continues to serve on the advisory boards of Open Source Ecology and Libre3D.

NEW FACULTY

Jeremy Bos, PhD



Jeremy Bos joins the Department of Electrical and Computer Engineering as an assistant professor. He comes to Michigan Tech from the National Research Council Research Associateship Program at the Air Force Research Lab in Hawaii. He received his PhD in Electrical Engineering from Michigan Tech and his Master's in High Frequency Communication Systems from Villanova University.

His research interests are in atmospheric optics, image and signal processing, autonomous vehicles, and industrial controls and robotics. He has been published in *Applied Optics*, *Optical Engineering*, and *Journal of Real-Time Image Processing*.

Aurenice Oliveira, PhD



Aurenice Oliveira joins the Department of Electrical and Computer Engineering as an associate professor. She earned a PhD in Electrical Engineering from the University of Maryland, Baltimore County, and a Master's in Electrical Engineering from the State University of Campinas in Brazil. Prior to joining the Department, she taught in the Department of Electrical and Computer Engineering at North Dakota State University, in the Mathematics Department at Minnesota State University, Moorhead, and in Michigan Tech's School of Technology.

She has published in the *IEEE Journal of Lightwave Technologies*, *IEEE Photonics Technology Letters*, *SPIE Optical Engineering*, and *Optics Letters*, among others. She is a senior member of the IEEE, and a member of the American Society for Engineering Education (ASEE) and the Society of Hispanic Professional Engineers. She is also an ABET Engineering Accreditation Commission Program Evaluator. Current research interests include

hybrid communications and networking, vehicular communications, optical fiber communication systems, and Monte Carlo methods applied to communications.



Faculty Fellow Program Aids Connection to University Operations

Keeping the lines of communication open between faculty, departments, and the University is the primary goal of Michigan Tech's Faculty Fellow Program (FFP).

Established in 2014, the FFP is operated through the Vice President for Research Office (VPR) at Tech and provides an opportunity for faculty voices to be represented in operational and management decisions made within the administration of the University.

That's critical, according to Electrical and Computer Engineering Professor Paul Bergstrom, who is currently a Strategic Planning and Budget Faculty Fellow.

"While many administrators in positions of authority within the University come out of academic programs and maintain modest scholarly pursuits, their primary roles remove them from a close connection with and visibility in the day-to-day impact of the many

management decisions that influence how the University functions," he says. "This program is intended to engage faculty in various aspects of these decisions, especially related to the introduction of new programs, operating frameworks, or other operational changes."

Faculty must apply to the program, and the selection of Faculty Fellows is done within the management team in VPR. Fellows propose a topic or focused effort to address a perceived or communicated need within the research community. Vice President for Research David Reed selects those Faculty Fellows that best fit within the needs stated by staff.

While the program is still relatively new, six faculty have participated to date. Bergstrom has been re-appointed for the 2016-17 academic year, and Brian Barkdoll, professor in Civil and Environmental Engineering, will also serve this year. Others who have been fellows include Larry Sutter, Materials Science and Engineering; Yoke Khin Yap, Physics; Rudy Luck, Chemistry; Alexsey Smirnov, Geological and Mining Engineering; and Adrienne Minerick, Chemical Engineering.

The program has been well received so far.

"Based on conversations with two of the recipients from the first year of the program, I received positive feedback on the value and impact that they perceived it had on their own perspective regarding the research endeavor at the institution," Bergstrom says. "The feedback was that it took a full year to be comfortable with the jargon and frameworks in place, and I have found that to be true. This past year was primarily spent learning what to do. I trust my second year will allow me to engage more meaningfully within the organization."

Overall, the FFP serves as an important bridge between faculty and the University.

"It allows the faculty to more clearly see the administrative roles and efforts in place within VPR more broadly," Bergstrom says. "There are many regulatory, administrative, financial, and oversight roles that faculty take for granted, but which are necessary to do well. It has given me more appreciation of the efforts in which the various organizations under VPR are engaged."

For more information or to apply for the Faculty Fellows Program, visit mtu.edu/research/administration/vpr-office.



Bo Chen, the Dave House Associate Professor of Mechanical Engineering and Electrical Engineering, works in two worlds, an arrangement that suits her just fine.

"With a joint appointment in ME-EM and ECE I am able to conduct multidisciplinary work and collaborate with researchers in different areas," she says.

And that work is extensive, including development of advanced control strategies for automotive and smart grid applications. Research projects have included:

- Advanced propulsion and fuel technology for sustainable transportation
- An Electric Vehicle (EV) smart grid integration requirements study. A smart grid is an electrical grid that includes a variety of operational and energy measures, including smart meters, smart appliances, renewable energy resources, and energy efficiency resources. Electronic power conditioning and control of the production and distribution of electricity are important aspects of the smart grid.
- Advanced gasoline turbocharged direct injection engine development, combustion control for spark ignition (SI) engines
- An interdisciplinary program for education and outreach in transportation electrification
- Hardware-in-the-Loop (HIL) simulation of electric power steering (EPS) systems
- Multi-agent network control for adaptive sensing and monitoring. Agent Technology includes computer programs that use artificial intelligence technology to "learn" and automate certain procedures and processes.

These research projects are funded by the National Science Foundation, the Department of Energy, and industry partners.

"Technologies for reduced fuel consumption and emissions in transportation are areas that need considerable advancement," Chen says. "The stringent government regulations require automotive manufacturers and the research community to explore potential technologies to reduce vehicle fuel consumption."

From Controls to Cyber-Physical Systems, Chen's Research Fills Critical Needs

Those technologies include Hybrid Electric Vehicles (HEVs), Plug-in Electric Vehicles (PEVs), as well as improving performance of conventional vehicles. With the increasing number of PEVs and EVs, the research to study their impact on the power grid and the development of smart-charging infrastructure through vehicle-to-grid integration technologies are critically needed, according to Chen.

Chen also does an extensive amount of research on controls.

"Controls play an important role in improving vehicle performance and managing energy usage in HEVs," she says. "The increasing processing power of the on-board vehicle controllers makes it possible to implement advanced control algorithms at various levels of vehicle control networks to maximize fuel economy and reduce emissions."

Chen and her students develop control strategies for HEV control and energy management, real-time internal combustion (IC) engine control, and adaptive sensing and monitoring. For HEV control, various optimal strategies such as model predictive control and instantaneous optimization method have been investigated for vehicle mode control and HEV energy management. The impact of driver's driving patterns and the vehicle driving cycles on fuel economy have also been investigated.

"A driving cycle pattern recognition algorithm has been developed to enable dynamic selection of optimal vehicle control strategies based on real-world driving cycles," she says. "At the HEV powertrain component level, we have studied real-time combustion control for IC engines and battery-health-conscious powertrain energy management strategies for HEV batteries."

Chen has been working with the EV-Smart Grid Interoperability Center (IOC) at Argonne National Laboratory (ANL) in Lamont, Illinois, since 2014. She led ANL's contribution to the multi-lab "EV Smart Grid Integration Requirements Study" funded by the Department of Energy.

"There are expectations that electrified vehicles can be an integral part of the smart, renewable electricity grid of the future," she says. "To work toward understanding this potential, a collaboration among six national laboratories leverages core expertise to define PEV grid integration scenarios and suggest research opportunities along with the necessary system implementation requirements."

Chen also supported the Grid Modernization Laboratory Consortium (GMLC), Devices and Integrated Systems Testing team in the development of the Grid Modernization Multi-Year Program Plan, and is currently working with ANL IOC to establish a grid interaction laboratory and develop advanced technologies for EV smart grid integration.

In addition, she has published over 80 peer-reviewed journal and conference papers in the areas of EV smart grid integration, HEV control, and agent-based intelligent systems.



Real-Time Information and Data Processing

Saeid Nooshabadi



Better, Faster Video Processing

When you view a YouTube video or a Netflix movie you are viewing tens of gigabytes of data compressed up to 50 times. The process to transmit what an HD camera captures requires large quantities of frame-by-frame video data transmissions. Such is the case in sports broadcasting—it must happen fast.

“We can take advantage of similarities of each frame to reduce the size of the transmissions,” Nooshabadi says.

In some cases like sports, where video is captured from multiple angles, electrical engineers and computer scientists can reconstruct missing coverage using free-view video technology. “The more cameras recording, the better,” he says. Computational complexity is high because sports coverage is real-time. Applications of Nooshabadi’s multi-view video processing work, funded by the National Science Foundation, includes not only sports reporting, but surveillance and even remote surgery.

Better, Faster Image Enhancement

In biological widefield microscopy, the objects being imaged are frequently three-dimensional, and the images contain out-of-focus light. The images can be combined, stacked, and processed using complex mathematical operations to enhance the quality. This technology can also be useful in consumer-imaging devices. Nooshabadi’s work is focused on acceleration of complex mathematical operations.

“One of my students is working with the Donald Danforth Plant Science Center in St. Louis to apply image registration techniques to phenotyping applications. The technique requires referencing data from multiple sensors to the same spatial location, so data from multiple sensors can be integrated and analyzed to extract useful information,” Nooshabadi says.

Previously, these technologies required supercomputers. Now with advances in mobile digital devices, the technology is becoming faster and more accessible.”

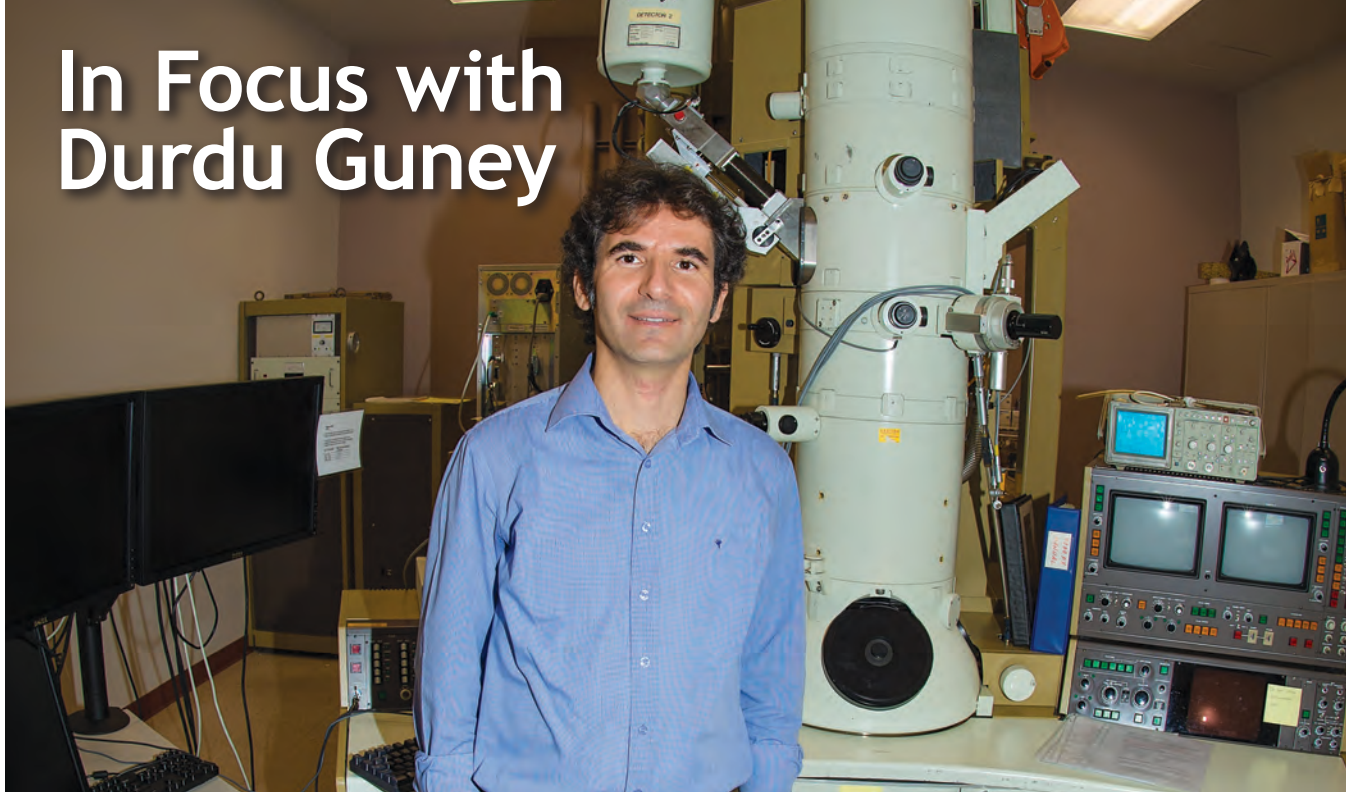
Better, Faster Big Data Processing

A variety of modern real-world Big Data applications, including sensing technologies, security, financial trading, epidemiology, networks, and scientific experiments, rely heavily on an adequate analysis of transient data streams.

To extract meaningful information from these Big Data streams, techniques in data-driven machine learning and analytics provide promising solutions, but the challenge to Big Data processing is extraction of useful information in real-time.

A typical example is the data classification in Big Data typically requiring analytics in a high-dimensional domain. Prior to data classification, datasets need to undergo a complex process of density. Nooshabadi and his students are looking at techniques to reduce the computational complexity of Big Data processing.

In Focus with Durdu Guney



What if you could put a million dollar microscope on your smartphone?

Durdu Guney, associate professor in electrical and computer engineering, is pushing the frontiers of metamaterials to make it happen.

Metamaterials are artificially designed materials. In nature, there are different types of materials and the optical properties do not change, but with metamaterials, you can actually bring some impressive optical properties by engineering at very small scales, making what is called a “perfect lens.” To do this, the bases used for making a metamaterial—like the thin silver films Guney’s group uses—are tweaked at the subwavelength scale so that light waves interact with the material in new ways.

While no one has created a perfect lens yet, the metal base Guney tests would look more like a traditional glass lens except for unprecedented image resolution; light would pass through instead of reflecting off of or being absorbed by the metal. In July 2015, the journal *Physical Review Letters* published his team’s study.

“Aluminum and silver are the best choices so far in the visible light spectrum, not just for a perfect lens but most metamaterial devices,” Guney says, explaining that metamaterials have been successfully created with these metals, although they still tend to absorb light waves. “Loss—or the undesired absorption of light—is good in solar cells, but bad in a lens because it deteriorates the useful light waves,” he explains.

The solution to absorption is all in the light waves themselves, which behave strangely in metamaterials. To create their sci-fi light-bending properties, a perfect lens relies on negative index metamaterials. Positive and negative refer to how a material responds to propagating and decaying light waves, which are like the yin and yang of optics. Most materials (positive index materials) allow only propagating light waves to pass through. Negative index metamaterials, on the other hand, don’t just pass through propagating light waves but also amplify the decaying light waves.

“In order for the perfect lens to work, you have to satisfy a lot of electromagnetic constraints,” Guney explains. “We

don’t know how exactly the required optical modes [light waves in the material] need to be excited and protected in the lens for the perfect construction of an image.”

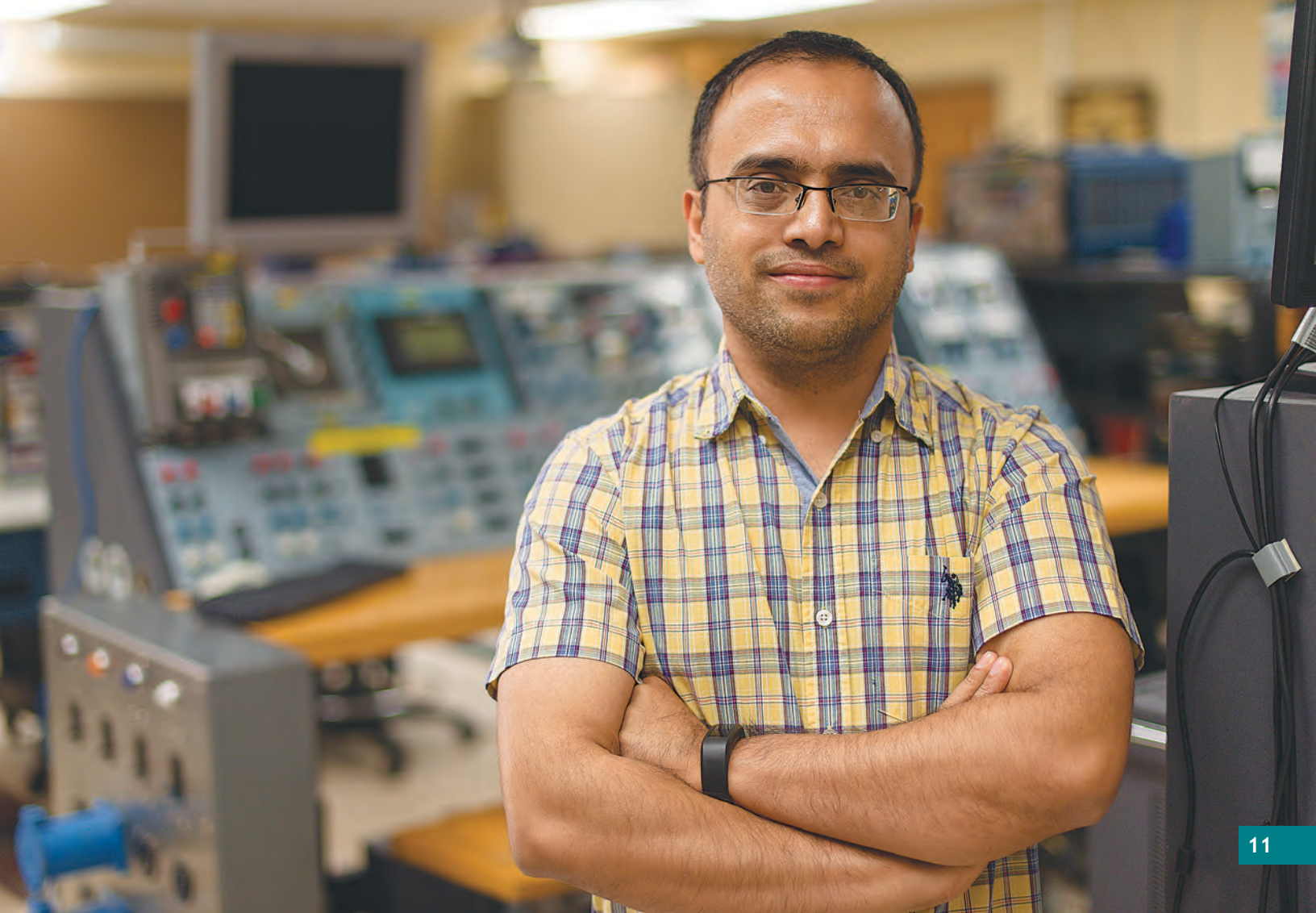
This difficulty has led researchers to try numerous modifications of the metamaterial make-up, adding bulk, mode-by-mode nit-picking, and increasingly complex models. But Guney and his team propose moving away from the complications and going back to the light itself. In their plasmon-injection scheme (shorted to pi-scheme or n-scheme), the researchers take advantage of knowing which light wave crumbles as it passes through the negative index lens. They use this wave—destined to fail in the lens—to shield the desired light wave, allowing it to pass through unscathed.

If perfected there are many applications for this technology.

“There would be huge impacts on society if you have access to a super lens,” says Guney, explaining it could improve chip manufacturing and photolithography, and make more powerful smartphones. “You need to improve the functionality of those phones by increasing circuitry, and to do that you need to go smaller and smaller in the components. Lenses can do that and ultimately improve devices by keeping their size constant.”

Currently, three students are working on the project with Guney: Mehdi Sadatgol, who also published in the *Physical Review Letters* study, as well as Wyatt Adams and Xu Zhang. The team is collaborating with researchers from the University of Michigan, University of California, Berkeley, Harvard University, and the Karlsruhe Institute of Technology in Germany.

“We have more than two years left on the project,” Guney says, adding that his team is applying for a patent and is in touch with the Office of Innovation and Industry Engagement at Michigan Tech to bring the technology to a commercial stage. “We are making good progress; this is very productive research and has big implications in industry, medicine, and chip manufacturing, sensing, spectroscopy, and data storage.”



Demand Dispatch: Keeping Power Balance in the Grid in a Nontraditional Way

Traditionally in the electric power grid, generation follows electric power consumption, or demand. Instantaneous fluctuation in demand is primarily matched by controlling the power output of large generators.

As renewable energy sources, including solar and wind power, become more prevalent, generation patterns have become random. Finding the instantaneous power balance in the grid is imperative. This can be achieved through the direct control of customer loads, or demand dispatch—the ability to precisely control individual loads.

Sensors, smart meters, smart appliances, home-energy management systems, and other smart-grid technologies facilitate the realization of the demand dispatch concept.

The use of demand dispatch has promising potential in the United

States, where it is estimated that one-fourth of the total demand for electricity could be dispatchable using smart-grid technologies. Coordination and control in real-time is crucial for the successful implementation of demand dispatch on a large scale.

Sumit Paudyal and his research team are developing real-time and efficient control algorithms to aggregate distributed energy resources, and coordinate them with the control of the underlying power grid infrastructure. Their goal is to control dispatch-distributed resources for the very same grid-level applications—frequency control, regulation, and load following—traditionally provided by expensive generators.

“We have solved the demand dispatch problem of thermostatically controlled loads in buildings, and electric vehicle loads connected to moderate-size power distribution grids,” Paudyal

explains. “Since the inherent challenge of the demand dispatch process is the computational complexity arising from the real-time control and coordination of hundreds to millions of customer loads in the system, we are now taking a distributed control approach to achieve computational efficiency in practical-sized, large-scale power grids.”

Compared to the traditional approach, which involves controlling a few large generators, maintaining the instantaneous power balance in the grid by controlling small and distributed energy assets at the customer end poses many challenges. “A typical grid can have hundreds to millions of distributed energy resources (loads or generation) at the customer end,” notes Paudyal.

Space, Solar Power's Next Frontier

Seyed (Reza) Zekavat



It's hard to say exactly where Seyed (Reza) Zekavat works. That's because his

research orbits the earth, dives underwater, peers into the human body, and stretches across cities.

Zekavat is a professor of electrical and computer engineering, and he connects the dots in complex electrical systems. He specializes in wireless communications, positioning systems, software-defined radio design, dynamic spectrum allocation methods, radar theory, blind signal separation, beamforming techniques, feature extraction, and neural networking.

He is the founder of the Wireless Local Positioning System Laboratory at Michigan Tech. The lab equipment and research has been supported by the National Science Foundation (NSF), the Army Research Labs, and National Instruments. Since 2005, he has mentored nine PhD students and many master's students. In addition, a group of undergraduate students have been involved in the Lab through the NSF Research Experiences for Undergraduates program.

Currently, his localization research in non-homogeneous and homogeneous environments seeks solutions in healthcare, mining, underwater exploration, and the creation of "smart cities."

"Our research involves near-ground channel modeling, finding the best localization methods that can be carried out for multilayer or non-homogeneous environments, including different materials with

different electromagnetic behavior," he says.

This research can improve localization of objects that are within the human body. With the emergence of capsule endoscopy (a small camera swallowed by the patient) and nanomachines used for cancer detection, it is critical for physicians to assign a location to the tumors. Current capsule endoscopy systems can make it difficult for doctors to know exactly where the photos are coming from. Zekavat is working on systems to improve that.

In the mining industry, sensors are used to explore oil fields and, currently, signals go through multiple wires to communicate with sensors in the oil field. Localization is a challenge, Zekavat says, but it is important to find techniques that can localize sensors when signals have to go through multiple layers of ground.

Another application is the potential to localize objects underwater using drones.

"We imagine using drones, which are much faster than using ships," he says. "Currently, using drones is not possible because the signal needs to go through two layers, water and air. Their electromagnetic behaviors make it very hard, but we're trying to find techniques that incorporate time-of-arrival estimation to localize in non-homogeneous environments."

Other projects in Tech's Wireless Local Positioning System Lab include the communications requirements of future smart cities like driverless cars and smarter power grids.

Zekavat also continues his work on space solar power (SSP). Introduced

in 1964 by NASA scientist Peter Glacier, SSP envisions the continuous harnessing of the sun's power by satellites that then beam that energy to earth. Right now solar power is delivered through earth-based systems that have both time and weather limitations. Space solar power could operate continuously.

Zekavat and others have been active in hosting workshops and discussions on some of the main barriers to SSP, including technological challenges, financial realities, and launching.

"We have been very successful in bringing many US and international scientists to this venue," he says. "Yet, we need more work to raise awareness in academia and policy makers in order for them to understand the importance and locate more funding for this technology."

At Michigan Tech, Zekavat's team is specifically working on the communication between the solar-power-collecting satellites and stations on the ground. They are also considering the use of low-earth-orbit (LEO) to lower the transmission attenuation. However, it would require a large number of satellites in orbit to maintain constant coverage with the ground, according to Zekavat.

Zekavat's work is interdisciplinary and he frequently partners with fellow ECE professor Sumit Paudyal as well as Ossama Abdelkhalik in mechanical engineering and Laura Brown from computer science, among others.



Kit Cischke

Award-Winning Senior Lecturer

Q: How long have you been teaching in the ECE Department?

A: Doc Wiitanen showed me into my office on August 15, 2005, so I just wrapped up my 11th year.

Q: What are your different roles and responsibilities?

A: I am a senior lecturer, teaching computer engineering classes (Networks, Digital Logic, and Embedded Systems). I'm the advisor for the Wireless Communications Enterprise, a group I helped start as an undergraduate here in 1999. I'm a member of the Undergraduate Program Committee, helping make curriculum decisions, and a member of the Communications Committee, helping the rest of the world know about all the good stuff we're doing. As an outgrowth of that, I run the ECE Department Twitter account (@mtuECE).

Q: Please list recent awards you have received.

A: In 2013, 2014, and 2016, I received the Eta Kappa Nu (HKN) Professor of the Year award, selected by a vote of ECE students. In 2015, I was honored in the Dean's Teaching Showcase.

Q: What about your PhD? What is the focus of your research?

A: Ahh, the endless PhD. My research involves the agent-based modeling of crowd movement. There have been tragedies throughout the years where a panicked crowd has trampled and killed people, from the 1913 Italian Hall Disaster in Calumet, Michigan, to a recent event at Mecca in Saudi Arabia. Current models for crowd movement dramatically simplify the situation to a fluid model—people are just molecules in a fluid—or queuing models, or similar models. None of these really capture the essence of the decision-making process of a human being in a crowd. When I'm exiting a stadium with my family, I have three smaller, slower humans (my

kids) that I'm not just going to leave behind. People also have habits that can't be accounted for in these old models—for instance, they always use a certain door, even if it's not the most efficient exit route. Agent-based modeling captures that irrationality as well as other characteristics of size, age, speed, aggressiveness, and more. Parallel programming models and parallel computers allow me to combine all these things using smaller computers.

Q: What is the most challenging aspect of your job?

A: Finding new ways to explain a topic to a student who is struggling. It challenges my own understanding of the topic. Also, students come up with some fabulously creative ways to approach the same problem. Some of those solutions have a lot of merit.

Q: What is the most rewarding aspect?

A: The first semester I was here, a student came to my office looking for clarification on a homework problem. I stood at my whiteboard and explained the mechanics behind the question. Eleven years later, I can still see that light of understanding dawning behind her eyes. Last summer, some students working on a programmable robot were literally jumping for joy when it did what it was supposed to do. Then I get to watch them go off and do such cool stuff at their full-time jobs. Grading exams at midnight suddenly becomes much less burdensome.

Q: What advice do you find yourself giving to students the most?

A: In no particular order: No number on a paycheck is worth doing a job you hate or living in a place you can't stand. Never use the conditional operator in any C-like language. Comments in your code are supposed to reveal the purpose of the code, not reiterate the functionality. Sleep more. Never stop learning. Go outside.

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ECE ACADEMY CLASS OF 2016

The purpose of the Academy is to honor outstanding graduates of the Department of Electrical and Computer Engineering at Michigan Tech. Election to the Academy is made by the executive committee of the faculty and recognizes excellence and leadership in the engineering profession and civic affairs. This induction honors some of the most successful of the more than 8,000 ECE alumni from Tech.



Richard J. Ford '77

Richard (Rich) Ford earned a BS in Electrical Engineering from Michigan Tech in 1977. Rich says he was fortunate to have studied under Dennis Wiitanen, who provided him with a solid technical background and some valuable life lessons. Upon graduation, Rich joined

Consumers Power Company, now Consumers Energy, in Jackson, Michigan.

Early in his career, Rich planned new generating resources, forecasted generating unit operation, and developed power purchase contracts, and was responsible for hydro license compliance. He managed the engineering group at Consumers' plant in Erie, Michigan, and also served as central region operations support manager and as electric field manager. He was also site manager of the Karn-Weadock Complex in the Bay City area. Rich completed his 37-year career at Consumers with assignments as vice president of energy delivery, vice president of generation operations, and vice president of transmission.

During his career, Rich represented Consumers before state regulators and non-profit research institutes. He is a licensed Professional Engineer in the state of Michigan and resides in Holland, Michigan, with his wife Suzanne.



Shankar Mukherjee '86

Shankar Mukherjee earned an MS in Electrical Engineering from Michigan Tech in 1986. He started his career at National Semiconductor in 1988, where he developed several Ethernet devices.

In 1996, he started the networking division at Enable Semiconductor.

As vice president of networking products, he led the company in developing several fast Ethernet products. He then served as director of LAN switching for Lucent's Microelectronics Group.

In 2000, he started TeraBlaze, Inc., which developed the first high-density 48-port Gigabit switch with two 10 Gigabit uplinks. In 2008, Shankar founded Dhaani Systems, Inc. in Cupertino, California, to produce energy-saving technologies for electronic systems. As the company's president and CEO, Shankar has brought several highly successful Silicon solutions to market.

He currently serves as a director of Dhaani Systems, has been a contributing member in the IEEE802.3 forum, was instrumental in standardizing the "auto-negotiation" protocol, and participated in the Entrepreneurship and Technology panel discussion at Michigan Tech. Shankar and his wife Phila reside in Cupertino.



Charles W. Rogers '78

Charles W. Rogers earned a BS in Electrical Engineering from Michigan Tech in 1978, where he was a member of Eta Kappa Nu, played with the jazz and campus concert bands, and participated in intramural bowling and softball.

After graduating, Charles joined Consumers Power Company, now Consumers Energy, as general engineer for their System Protection Division. He was later promoted to senior engineer, division head/instructor of design and standards, and then System Protection's lead relaying engineer. As a principal engineer at Consumers Energy, Charles handles transmission system protection, the interconnection protection of distributed generators, and switching surge analysis. He has also served on numerous committees and task forces with the North America Electric Reliability Council (NERC) for transmission and distribution compliance activities. He currently chairs the NERC team that is developing PRC-005-2 for Protection System Maintenance. Charles is also a senior member of IEEE and an active member of the IEEE Standards Coordinating Committee.

Charles enjoys motocross, whitewater canoeing, fishing, and travel. He and his wife Lynn Conway reside in Jackson, Michigan.



Paul Fulton '84

Paul Fulton earned his BS in Computer Engineering from Michigan Tech in 1984. Early in his career, he served in management positions for Compaq Computer and Texas Instruments, and co-founded Orative Corporation, a successful wireless communications product company.

Over the course of his career, Paul has been vice president and general manager of 3Com's Wireless Division, where he spearheaded the company's entry into wireless markets; was executive in residence for Mayfield, a venture capital firm; and founded and served as president and CEO of Orative, a market leader in collaborative mobile telephone software. When Cisco acquired Orative in 2006, Paul joined Cisco as an executive and held high-level M&A, market development, product management, and strategy roles.

Paul is currently CEO of Zentri, a company that focuses on changing the way product companies deliver secure mobile and cloud connected products. He has testified before the US Congress and the Federal Communications Committee on wireless matters and holds numerous communications-related patents.

STAFF PROFILE: MICHELE KAMPPINEN

Whether you are a current or prospective student, alumnus or alumna, visitor or employee, if you have come to the ECE office, you have met and most likely remember Michele Kamppinen.



Michele has cheerfully greeted and assisted tens of thousands during her 20 years as office assistant for the ECE Department. She also helps to keep the faculty, staff, and students on track with the daily deadlines and functions that take place within a department of over 900 individuals.

Liz (Cloos) Dreyer '12 agrees. "One thing I remember about Michele is her ability to keep track of what was going on in the department, even though there was always so much happening at any one point in time."

Scotty Geverink '13 recalls his time as an ECE tour guide. "I miss giving building tours and being an electrical engineering student at Michigan Tech, and Michele is for sure a big reason behind that. The couple of times I came back to Michigan Tech for Winter Carnival or recruiting, I made sure to stop by the office and say hi to her, just like I did when I gave the tours. Michele is just an incredible person, great to talk to, greets everyone with a smile on her face, and is very helpful to current and prospective students."

This past June, the University recognized Michele for her 25 years of service, the first five of which were with the Human Resources Office.

Besides her ECE family, Michele and her husband Dale have a son and two daughters, Philip, Kyllie, and Lisa, and a granddaughter, Ellah.

ECE is pleased to acknowledge its appreciation for all that Michele has done and continues to do to make the department one of the best!



STAFF DIRECTORY

Joan Becker	ECE Graduate Program Coordinator
Judy Donahue	ECE Undergraduate Advisor
Trever Hassell	CpE Undergraduate Advisor and Instructor
Lisa Hitch	Business Manager and Technical Communications Specialist
Michele Kamppinen	Staff Assistant
John Kolacz	Research Associate
Chuck Sannes	Laboratory Supervisor
Mark Sloat	Research Associate

For the Love of Teaching: Jenn Winikus



Jennifer (Jenn) Winikus began her PhD studies in computer engineering at Michigan Tech in fall 2010, after earning a BS and MS in Electrical Engineering from Alfred University.

After several semesters of work and successfully completing her written and oral exams, Winikus connected with her advisor, Laura Brown, and began to focus on research in the area of machine learning.

In between her first days of orientation and final runs of computer simulation for her dissertation, Winikus became an invaluable asset to the ECE Department and the University, discovering her love of teaching along the way.

While at Tech, Winikus has worked especially hard to educate and engage young people through STEM education and outreach. "Thousands of students ages 10 through 17 have come through the ECE labs since I started working with Michigan Tech's Summer Youth Programs (SYP). Many are now enrolled at Tech. Some are in college and chose engineering because I helped show them that they can do it. This feels like my greatest success to date," she says.

"I try to keep students working together, being creative and open to the idea that things are interdisciplinary. I think that helps make students more open-minded about their future, whichever path they take."

Winikus has worn many hats over the past six years. She holds the record for serving the most times as a student facilitator for Michigan Tech's Graduate Student Orientation. "A great part of my own experience has been helping to welcome new students every semester," she says.

Winikus also launched the ECE Department Peer Mentoring Program. It pairs an incoming student with a returning student and encourages them to contact each other. The goal of the program is to help a new student gain early access to someone who has been in his or her shoes. "It took me a while to find a network of peers," says Winikus. "I

started out joining a sorority, but it was not a good fit in the long run. The long line of students in the ECE main office at the start of each semester has shrunk since the program started. It feels like we have a closer community since we are talking to each other more."

Staying focused was one of the most challenging aspects of her doctoral studies at Michigan Tech "There were times when helping students with homework, volunteering, or graduate student government was more of an interest to me than getting research done," she says. "Dr. Brown helped me get to the finish line. I have learned a lot from her."

Winikus' research focuses on the representation of outpatient medical data, and she conducts analysis using classification and regression approaches. "This kind of data is non-uniform and multimodal, but the idea can be applied with variation to other problems with multiple types of data, such as microgrid control or disease recognition." She also has an interest in autism. "I would like to take my knowledge of electrical and computer engineering and use it to help caretakers prevent meltdowns, either through warnings or an adaptive system."

Though she grew to love research, something powerful occurred when Winikus began working as a TA, at the urging of Department Chair Dan Fuhrmann and Glen Archer. "I found that teaching is really what I want to do," she explains.

"I had no interest in teaching when I started, but teaching Digital Logic was amazing. Through the process, Dr. Archer taught me a lot about working with students and course materials. Those were some of the most helpful experiences, especially with where I am going in the future."

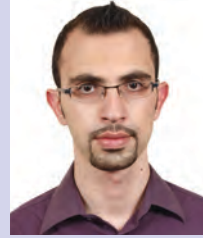
This past fall, Winikus joined the University at Buffalo Department of Computer Science and Engineering as a teaching assistant professor.

ECE GRADUATE STUDENT HIGHLIGHTS

Fellowship Recipients for 2015-16



Conway Fellow:
Aishwarya Mundada, MSEE
Degree awarded: Spring 2016
Advisor: Joshua Pearce



Jackson Professorship Fellow:
Husam Sweidan, PhD candidate
Expected graduation: Spring 2017
Advisor: Tim Havens



House Professorship Fellow:
Marco La Manna, PhD candidate
Degree awarded: Summer 2016
Advisor: Daniel Fuhrmann



Miles Fellow:
Mohsen Jamalabdollahi, PhD candidate
Degree awarded: Summer 2016
Advisor: Reza Zekavat

ECE Award Recipients for 2015-16



Matt Wolfe Award for
Outstanding GRA:
Mehdi Sadatgol



Jonathan Bara Award for
Outstanding GTA:
Bin Zhou

ECE Doctoral Degrees: August 2015 to May 2016

PhD Graduate	Advisor	Dissertation Title
Lengfei Han	Zhuo Feng	Scalable Integrated Circuit Simulation Algorithms for Energy-Efficient Teraflop Heterogeneous Parallel Computing Platforms
Kevin Kruse	Christopher Middlebrook	Multi-Mode and Single Mode Polymer Waveguides and Structures for Short-Haul Optical Interconnects
Amir Torabi	Seyed (Reza) Zekavat	Channel Modeling for Fifth Generation Cellular Networks and Wireless Sensor Networks
Ankit Vora	Durdu Guney	Increasing Solar Energy Conversion Efficiency in Thin Film Hydrogenated Amorphous Silicon Solar Cells with Patterned Plasmonic Silver Nano-Disk Array

The Silicon Valley Experience

It's become an annual spring break event. Twenty Michigan Tech students spend a week in California's Bay Area learning about companies, culture, and all things California.

Selected from a competitive pool of almost 100 applicants, these engineering and business students have a self-identified desire to learn more about what it means to be an entrepreneur. And what better place to see what it's all about than in Silicon Valley? Supported by gifts from alumni Rick Berquist and Tom Porter, and organized and supported by the School of Business and Economics and the Center for Entrepreneurism in the Pavlis Honors College, the students spent a week in March at Meraki/Cisco, Autodesk, Porter Family Vineyards, Netflix, Apple, Facebook, Ford, Brocade, and Clari, as well as recent Michigan Tech alumni startup companies Skymind and Handshake. ECE Department Chair Dan Fuhrmann joined the group to see firsthand what attracts the students to pursuing entrepreneurship.

Silicon Valley has established itself as the center of the universe when it comes to innovation in the information technology space. There is no other place like it. It is brimming with all sorts of electrical engineers, computer engineers, software engineers, and entrepreneurs working to create the next big thing and disrupt last year's technology, with the support of a massive economic engine of venture capital. Almost overnight, it seems, the technology created there has gone from a novelty to a necessity—search engines like Google, smartphones from Apple, social media like Facebook. There is a lot of

excitement and buzz surrounding these technological innovations, and as a result, Silicon Valley attracts the best and brightest engineering talent. There are a lot of job opportunities, but even so, the market can be very competitive as the top companies can afford to be choosy. Job interviews have been transformed from conversations across a desk to auditions of actual programming and engineering skill.

The culture of entrepreneurship, which has taken California by storm and has become part of the national conversation, is having a big impact on engineering programs, especially in electrical engineering and computer science. It is clear that starting a company is now one of the options available to young engineers, right alongside getting a job at an established company or going to graduate school. The question is, what can we do, and what should we do, as educators to prepare students for this brave new world?

Michigan Tech is addressing this question head-on. We have established a Center for Entrepreneurship and Innovation, precisely to help students learn about project management, innovation, entrepreneurship, and business practices in the high-tech environment. Students from all different disciplines have the opportunity to participate in the Center, and indeed it played a role in the "Silicon Valley Experience." The Center is getting a lot of attention from philanthropically minded alumni, and rightly so. We expect it to be a big success, and a big draw for new students coming to Michigan Tech.



We Inspire Wins Highest Growth Potential Award



We Inspire, led by BSEE senior Arick Davis, won \$10,000 in seed money from the Korson Family for Highest Growth Potential at the 2016 New Venture Competition hosted by Central Michigan University this April.

We Inspire is developing an online system and community to help students make informed career choices by connecting them with profiles and feedback from practicing professionals.

The Pavlis Honors College helped sponsor the event financially. The student teams received support from Michigan Tech's Innovation Center for Entrepreneurship, the School of Business and Economics, and the MTEC SmartZone.

Arick Davis is pictured third from left.

ECE SENIOR DESIGN



SD-8 American Transmission Co. team members: Jacob Marshall, Kevin Schoenknecht, and Troy Johnston; Advisor Prof. John Lukowski

Our Discover-Design-Deliver philosophy is at the core of our Senior Design program, where students experience a project's entire design process as it would be in industry. Students enrolled in Senior Design work as teams on client-based engineering projects under the consultation of a client representative and the direction of a faculty advisor. Our Department's Senior Design experience spans a full year, by the end of which a team has delivered design reviews, a final report, a formal presentation, and an end product to the client.

The following were our Senior Design Teams for the 2015-16 academic year.

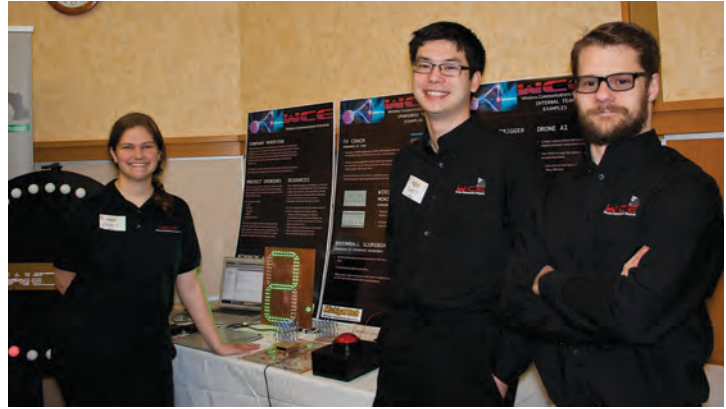
Projects	Sponsor	Advisor
SD-1 / Railroad Car Wheel Contamination Detection	Norfolk Southern Corp. and Tech's NURail	Duane Bucheger
SD-2 / HiL Design	Nexteer Automotive	Jeff Burl
SD-3 / Utility UAV - Specification Performance Team	ITC Holdings Corporation	Duane Bucheger
SD-4 / Utility UAV - Inspection Interface Team	ITC Holdings Corporation	Trever Hassell
SD-5 / RAM Electrification and Idle Management	Fiat Chrysler Automobiles	Duane Bucheger
SD-6 / Scaled Electrical Leak Location Solution	Electroscan, Inc.	Jeff Burl
SD-7 / Underground System Protection	DTE	John Lukowski
SD-8 / Traveling Wave Fault Location		
<ul style="list-style-type: none"> • 2016 Design Expo Honorable Mention Award • 2016 Larry Kennedy Industrial Innovation Award 	American Transmission Co.	John Lukowski

ECE ENTERPRISE

Wireless Communication Enterprise

The goals of the Wireless Communication Enterprise are to develop a student-owned culture that fosters high professional standards, mutual respect, creativity, productivity, effective personal communication, and a burning design to learn; and to create projects that advance the communication industry and that generate an intense learning environment for Michigan Tech students. We intend for our graduates to be ready for the most challenging careers. The following are the 2015-16 senior-level projects for WCE.

WCE Advisor: Kit Cischke



WCE members (l-r): Chloe Sult, Scott Pomerville, and Tino Moore

Projects	Sponsor
EV Coach, real-time performance feedback while driving electric and hybrid electric vehicles	Ford Motor Company
Wireless Battery Monitoring, to monitor the "health" of battery packs	Ford Motor Company
Geofencing mobile devices and transitioning a smartphone app to a web app	Kyocera Document Solutions USA
Drone AI	ECE Department
Building Bluetooth speakers for Texas Instruments Innovation Challenge	ECE Department
Controls Wildcard, a double pendulum and control system to balance it upright	ECE Department
Build and test Bluetooth dongles used by first-year engineering students to program Roomba robots with Matlab	Engineering Fundamentals
Wireless MIDI, design of reliable wireless triggers for on-stage sound effects	Michigan Technological University Department of Visual and Performing Arts
Broomball Scoreboard	IRHC Broomball



Hybrid Electric Vehicle (HEV)

The HEV Enterprise is a collaborative activity between the ECE Department and the Department of Mechanical Engineering-Engineering Mechanics (ME-EM). The goal is to develop skills applicable to the design of advanced hybrid vehicles, which are known to be fuel-efficient and environmentally friendly. The 40+ member enterprise comprises various teams for accessory drives, battery control systems, engine modeling, platform, and transmission.

HEV Advisors: John Lukowski (ECE) and Robert Page (ME-EM)

Project	Sponsor
The HEV Enterprise is in the final stages of hybridizing a 1949, 5-window Chevrolet pickup truck. The design features a 326HP small block Chevy engine coupled to a 75kW Remy electric motor. Power is delivered to a Mustang IRS through a Tremec 5-speed transmission that the controls team has converted to an auto-shifter. Energy comes from a 14-gallon gasoline fuel cell and a 23kWhr, A123 Li-Ion battery.	General Motors, major technical and monetary contributor

ECE ENTERPRISE



Blue Marble Security Enterprise

The goal of Blue Marble is to create sustainable, secure systems for our sponsors—either corporate or within the University. Blue Marble Security is made up of several sub-teams, each working on projects related to security. Though located in the ECE Department, Blue Marble members come from a host of other disciplines, including mechanical engineering, computer science, and business. The following are the 2015-16 senior-level projects for Blue Marble.

BMS Advisor: Glen Archer

Projects	Sponsor
Drop Weight Tear Test (DWTT) samples	ArcelorMittal
Wheel Tractor Scraper Bowl Optimization System	Caterpillar, Inc.
Mechanical Actuator System	Halla Mechatronics
Team Autobot, for 2016 Intelligent Ground Vehicle Competition (IGVC) at Oakland University (Advisor: Jeff Burl)	ECE Department
Website development for BMS	ECE Department
Project X, design of a new solder lab outreach project	ECE Department
CUAV, design of a moderately autonomous counter UAV system	ECE Department
The Outreach team hosts multiple events throughout the year, both to foster an interest in STEM among the youth in the community and to spark an interest in electrical and/or computer engineering among the first-year students at Michigan Tech.	ECE Department

Robotic Systems Enterprise

The Robotic Systems Enterprise is an innovation-driven student team that focuses on integrating knowledge in electronics, robotics, programming, and mechanical principles to solve real-world engineering problems. From designing a soil-sample-collecting submersible robot, to a power management system for weather buoys, and a counter UAV to prevent invading drones, RSE projects come in all shapes and sizes.

RSE Advisor: Glen Archer



Projects	Sponsor
Improved power management system for GLRC's weather buoys	Great Lakes Research Center (GLRC)
Submersible robot	Great Lakes Research Center (GLRC)
Counter UAV	ECE Department
Exoskeleton	ECE Department

Undergraduate Student Awards



ECE Departmental Scholar:
Derek Gheller



ECE Woman of Promise / Martha
Sloan Scholarship: **Alexis Dani**



Carl S. Schjonberg Award for
Outstanding Undergraduate Student:
Ian Cummings

ECE EXTERNAL ADVISORY COMMITTEE

The mission of the committee is to serve the Department of Electrical and Computer Engineering in an advisory capacity, providing counsel to the department chair and the faculty from the viewpoint of industry. The aim of these activities is to improve the quality of electrical and computer engineering education at Michigan Tech and provide ECE graduates who are valuable assets to industry employers.



EAC members

Ben Galloway
Dematic Corporation

Anthony Champagne
Nexteer Automotive

Ken Leisenring
Ford Motor Company

David Aho
Eaton Cooper Power
Systems

Ellen Bauman
IBM

Matt Schroeder
General Motors

Jonathan Doane
MIT Lincoln Laboratory

David Rowe
Systems Control, a Division
of North Star Industries, Inc.

Dave Perry
Independent Consultant

Gordon Halt
ITC Holdings Corp.

Steven Kennell
Rockwell Collins

William Lepak
ArcelorMittal

Brett Giem
Chrysler Technology Center

Missing from photo:

Rob Cooke
GS Engineering

Eric Larson
3M Corporate Research

Steve Mathe
Harris Corporation

Nirmal Singh
DTE Energy

CONTRACTS AND GRANTS

Engineering research and development are key to technological progress and economic revitalization, and the ECE Department at Michigan Tech is busy doing its part. Our faculty, graduate students, and undergraduates work together in modern, well-equipped laboratories to bring practical solutions to real-world problems in signal processing, wireless communications, computer-aided design, energy systems, electronic materials and devices, photonics, and much more. Our research is funded by government agencies such as the National Science Foundation, the Department of Defense, and the Department of Energy, and by industrial partners such as Google, Ford Motor Co., American Electric Power, Xcel Energy, Dow Corning, and Nexteer Automotive. The ECE Department is eager to tackle new challenges and is always looking for new opportunities that are well matched to the interest and expertise of our faculty.

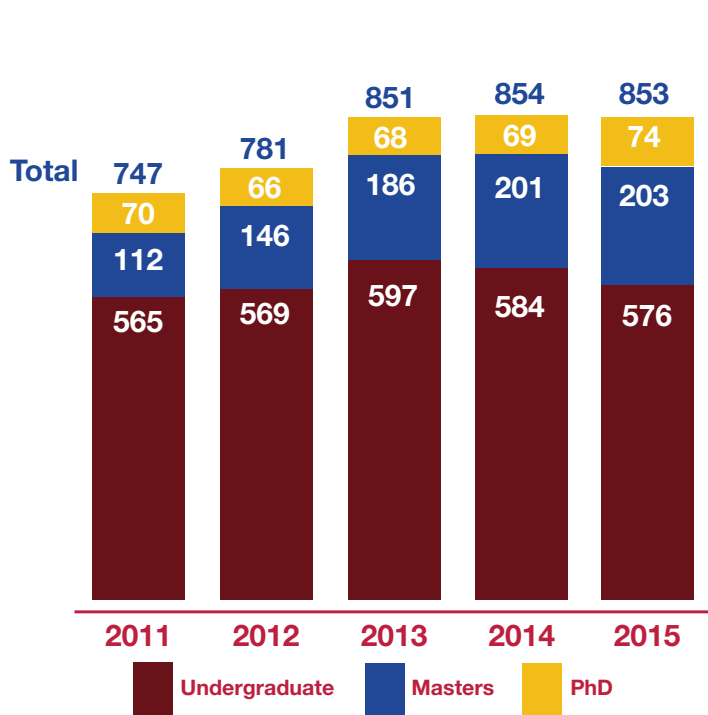
ECE Contracts and Grants Awarded July 2015 to June 2016

Title	Name	Sponsor	Award
CAREER: Leveraging Heterogeneous Manycore Systems for Scalable Modeling Simulation and Verification of Nanoscale Integrated Circuits	PI: Zhuo Feng	National Science Foundation	\$304,417 (\$69,885 FY16)
SHF: Small: Scalable Spectral Sparsification of Graph Laplacians and Integrated Circuits	PI: Zhuo Feng	National Science Foundation	\$450,000
Verification of NUADC Performance	PI: Dan Fuhrmann	Google Inc.	\$175,000
Full Compensation and Control of Losses in Metamaterial Devices without Gain Medium	PI: Durdu Guney	US Dept. of Defense	\$186,305
Increasing Solar Energy Conversion Efficiency in Hydrogenated Amorphous Silicon Photovoltaic Devices with Plasmonic Perfect Meta-Absorbers	PI: Durdu Guney	National Science Foundation	\$138,491 (\$14,000 FY16)
Heterogeneous Multisensor Buried Target Detection Using Spatiotemporal Feature Learning	PI: Tim Havens	US Dept. of Defense	\$285,900
Multisensor Analysis and Algorithm Development for Detection and Classification of Buried and Obscured Targets	PI: Tim Havens	US Dept. of Defense	\$99,779
CAREER: Integrated Research and Education in Physical Design Automation for Nanotechnology Technology Co-Design	PI: Shiyuan Hu	National Science Foundation	\$286,402 VLSI (\$85,702 FY16)
Power System Protection in a Smartgrid Perspective – Prosmart	PI: Bruce Mork	Norwegian University of Science and Technology	\$64,948
Transformer Protection – Improved Methodologies and Engineering Tools	PI: Bruce Mork	Bonneville Power Administration / US Dept. of Energy	\$150,000
Wave Optics of Deep Atmospheric Turbulence: From Underlying Physics Towards Predictive Modeling Mitigation and Exploring	PI: Mike Roggemann	University of Dayton / US Dept. of Defense	\$202,812
NSF Student Travel Grant for 2016 IEEE International Conference on Computer Communications (IEEE INFOCOM)	PI: Zhaohui Wang	National Science Foundation	\$25,000
Advanced Control and Energy Storage Architectures for Microgrids	PI: Wayne Weaver	Sandia National Laboratories / US Dept. of Energy	\$80,494 (\$31,858 FY16)
Unstable and Pulse Load Control Designs for Naval Electrical Systems	PI: Wayne Weaver	Sandia National Laboratories / US Dept. of Energy	\$110,801
Autonomous Microgrids: Theory Control Flexibility and Scalability	PI: Wayne Weaver	US Dept. of Defense	\$119,997
Workshop on Challenges for Space Solar Power	PI: Reza Zekavat	National Science Foundation	\$24,954

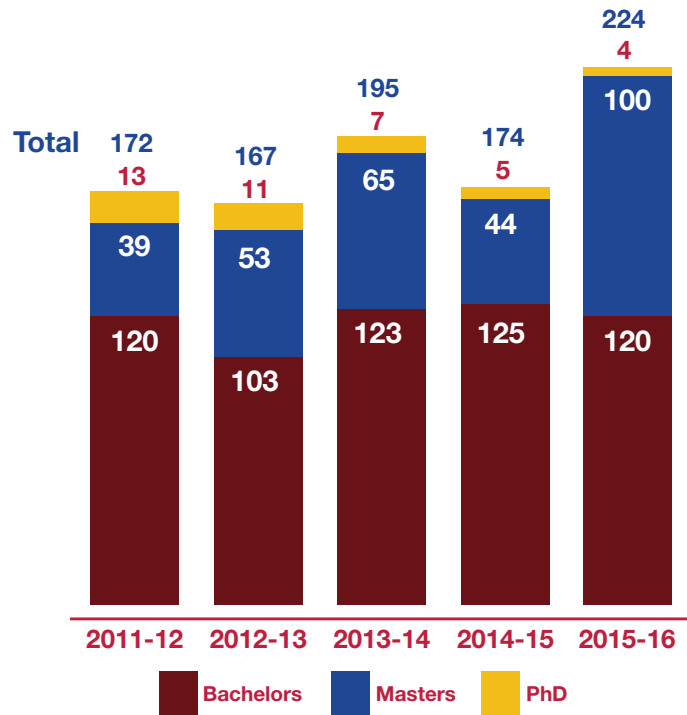
Please Note: Due to disclosure restrictions, some awards may not be listed.

DEPARTMENT STATISTICS

ECE Enrollment

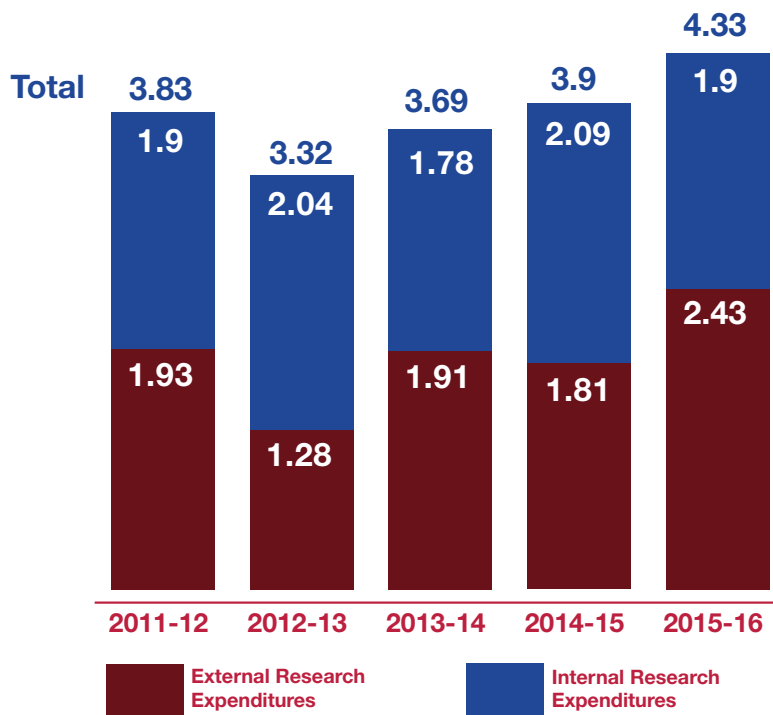


ECE Degrees Awarded



ECE Research and Sponsored Programs

Expenditures in Millions





**Michigan
Technological
University**

Department of Electrical and Computer Engineering

Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295

Sarah Rajala '74 Honored with AAES National Engineering Award



Sarah Rajala, dean of the Iowa State University College of Engineering, has earned the National Engineering Award from the American Association of Engineering Societies (AAES) – representing 17 multidisciplinary engineering societies from industry, government, and academia.

Rajala received the award on April 18 at a ceremony in Washington, DC. Rajala earned her bachelor's degree in electrical engineering from

Michigan Tech in 1974 and master's and PhD degrees from Rice University.

The AAES National Engineering Award recognizes her outstanding service in three key areas: 1) inspirational leadership at the institutional, national, and international levels; 2) innovations in engineering education and assessment; and 3) her tireless efforts to promote diversity in the engineering field.

"It is indeed appropriate that Sarah Rajala receive the AAES National Engineering Award," said Joseph J. Rencis, president of the American Society for Engineering Education, one of the AAES member societies. "She is a trailblazer and embodies the criteria of inspirational leadership and devotion to engineering education, advancement of the engineering profession, and promotion of public policies." Rencis also praised Rajala's

diversity efforts, adding, "Sarah has recognized the engineering profession cannot achieve full success without full participation of the rich diversity of talent in our global population."

From Michigan Tech, Rajala received the Distinguished Alumni Award in 2008; was inducted into the Electrical and Computer Engineering Academy in 1997; became a charter member of the Presidential Council of Alumnae in 1997; and earned the Outstanding Young Alumni Award in 1986.

She joined Iowa State in 2013, after having served as the first female dean of the Bagley College of Engineering at Mississippi State University. Before she became dean, Rajala was the first female tenure-track professor in the engineering department at North Carolina State University, where she organized networking activities for the college of engineering women faculty and helped create a maternity leave policy for tenure-track faculty members where none had existed.

In the classroom and through professional organizations, Rajala has worked to improve engineering education for students. She has received numerous teaching awards, provided key leadership related to reforming engineering education, and was elected president of the American Society for Engineering Education (ASEE) in 2008-09.

The focus of Rajala's research is the analysis and processing of images and image sequences and engineering educational assessment. She has directed numerous master's theses and doctoral dissertations, authored and co-authored nearly 200 publications, and secured a patent on image sequence compression.