Michigan Technological University

2019 ANNUAL REPORT

ELECTRICAL AND COMPUTER ENGINEERING

More Than Mere PCBs:

In the Classroom, In the Industry

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FROM THE CHAIR

Glen Archer
Principal Lecturer and Interim Chair

Hello from the beautiful Michigan Tech campus on the Keweenaw waterway. I am Glen Archer, interim chair of the Department of Electrical and Computer Engineering, and I am proud to present our 2019 Annual Report, which covers activity in the ECE Department for the 2019 fiscal year, running from July 1, 2018, to June 30, 2019.

Last year was another year of tremendous transition at Michigan Tech. With the new senior leadership solidly in place, things got moving across campus. ECE Chair Dan Fuhrmann completed his work with the Working Group on Computing and Information Sciences, and the University stood up the new College of Computing in July of 2019. In the fall 2018 semester, President Rick Koubek and Provost Jackie Huntoon launched a series of campuswide conversations known collectively as "Tech Forward." In addition to the new College of Computing, Kellie Raffaelli was appointed special assistant to the president for diversity and inclusion, and one of her first duties was to launch a nationwide search for a new vice president for diversity. Lorell Meadows, the dean of the Pavlis Honors College, was also charged with propagating the PHC's Learning Objectives throughout the University. Six other high-profile initiatives resulted as well, with two of those connected strongly to the College of Engineering and ECE: Advanced Materials and Manufacturing, led by Greg Odegard, and Autonomous and Intelligent Systems, led by Jeff Naber.

Led by Dan, the Working Group on Computing and Information Sciences produced an irrefutable recommendation to the Michigan Tech Board of Trustees: The creation of a College of Computing was needed to elevate computing at Michigan Tech, drawing on existing strengths and opening up new opportunities and degree programs in health informatics, cybersecurity, and entrepreneurship. The structural changes brought by the newly created College will position Michigan Tech as a leader in computing, as it is already a leader in engineering. Because of his passion and commitment to this revolutionary venture, Dan decided to invest fully in its launch and growth, and proposed his resignation as chair of the ECE Department. And so, I was appointed as the interim chair, with my first task to organize a search committee to find a new chair. Serving as the associate chair under Dan, and now the interim chair, has been an amazing experience and I am deeply honored by the confidence and support I have received from the faculty, staff, and students of the ECE Department. We have a fabulous future; it will continue to be a privilege to guide it as our path unfolds.

While all this was going on across the campus, ECE faculty and staff were busy doing what they do best: teaching our students, conducting leading-edge research, and guiding our student chapters of professional societies. Several of our faculty members and their educational and research activities are profiled in this report. I especially want to draw attention to Dr. Christopher Middlebrook, who achieved approval for the new Plexus Maker Lab, and created the fabulously successful printed circuit board (PCB) design and fabrication course in cooperation with Calumet Electronics, Systems Control, Schweitzer Electronics Lab (SEL), and Altium design software. The PCB course expands our footprint as part of an electronic systems manufacturing initiative intended to close a critical gap in our nation's security. I also want to acknowledge Dr. Jeremy Bos for his hard work with students in the Robotic Systems Enterprise and its flagship project, the GM/SAE AutoDrive Challenge. In the latest competition, they won fourth place overall against lavishly funded competition. We're very proud of his accomplishments, and you'll enjoy reading about them. Dr. Mike Roggemann, of "Paulding Light Mystery" fame, is also featured, along with research associate Mark Sloat.

In April, Dan and I proposed the creation of a new degree program in Robotics Engineering to be offered in the ECE Department. This cross-cutting degree draws on expertise in electrical, computer, and mechanical engineering; computing; human machine interface; and ethics, and will prepare students to take their place in the Fourth Industrial Revolution. The approval process is long, but the longest journey begins with a single step. We have taken that step hopefully and resolutely.

That is only a small sample of what's in store for you in this edition of the ECE Annual Report. As you read further, you will see we have been busy. But, we are never so busy that a phone call (906-487-2789) or email (gearcher@mtu.edu) from our alumni isn't a welcome distraction. If you have stories you want to share, or just want to hear about what's going on this week, please don't hesitate to reach out.

Glen Archer
Interim Chair, Department of Electrical and Computer Engineering

On the Cover
More Than Mere PCBs: In the Classroom, In the Industry
By Kelley Christensen

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WELCOME

Schulz Named 2019 University Professor

Dr. Tim Schulz, professor of electrical and computer engineering, received the 2019 University Professor award. The University Professor title recognizes faculty who have made outstanding scholarly contributions to Michigan Tech and their discipline over a substantial period of time.

During his 27 years at Michigan Tech, Schulz has displayed exemplary commitment to excellence in teaching, research, and administration. He became ECE department chair in 1997, and in that role, tripled the PhD program size and developed a BS degree in computer engineering. In 2007, he was promoted to full professor and became dean of the College of Engineering. As dean, he led efforts to establish goals in faculty achievement and recognition, research, and educational programs, and added relative goal progress measurements.

Since stepping down as dean, Schulz has been an ECE faculty leader in the use of technology to deliver technical material in electrical engineering and the development of new online courses.

Tim Schulz (center) stands with Provost and Senior Vice President for Academic Affairs Jackie Huntoon and former ECE Chair Dan Fuhrmann at the faculty awards ceremony September 18, 2019.

Bohmann Honored by ASEE ECE Division

Dr. Leonard Bohmann, associate dean of the College of Engineering and ECE professor, received the 2019 Meritorious Service Award from the ECE Division of the American Society for Engineering Education (ASEE). The award recognizes significant and meritorious service to the ASEE ECE Division over an extended period of time.

Bohmann received the award June 18, 2019, at the ASEE annual conference in Tampa, Florida. He is an active member of the ASEE and a former president of its ECE Division. He is also a member of the Energy Conversion and Conservation, Computers in Education, and Educational Research and Methods Divisions.

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Faculty Directory

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FACULTY HIGHLIGHTS

Sabbatical and Leave Activity

During 2018-19, **Saeid Nooshabadi** took a partial professional leave of absence to work with Ford Motor Company in their Autonomous Vehicle Division, and as part of an Alliance University project.

With Ford, Nooshabadi worked with a team of researchers and engineering in Palo Alto, California, and Dearborn, Michigan, on several projects relating to autonomous vehicles, including radar imaging, video sensing, and a computer vision algorithm for trailer angle detection for the F-150 pickup. He was also one of the drafters of the highway autopilot sensing requirement—camera, radar, and lidar—for Level 3 advanced driver assistance systems (ADAS).

As part of the Alliance University project, Nooshabadi and his PhD student developed a new deep-learning-based algorithm to detect trailer angles. Nooshabadi also participated in the development of a radar-based trailer angle detection algorithm.


Tim Havens

Tim Havens took a sabbatical from teaching in 2018-19 to focus on new activities. He said his sabbatical turned into "an ongoing collaboration, with several joint proposals in the works."

During 2018-19, Havens started his role as chief scientist for Signature Research Inc. in Calumet, Michigan. Signature Research develops innovative tools that use high-fidelity, physics-based approaches for applications, including signature management, modeling, and simulation. Havens is helping build the company's capabilities in machine learning and artificial intelligence for defense applications, and he collaborated on a project funded by the National Geospatial-Intelligence Agency to examine machine learning algorithms for detection of overhead infrared imagery. Havens also recruited one of Signature Research's employees to become a doctoral student in Michigan Tech's Department of Computer Science, in which he teaches.

Havens also started as director of Michigan Tech's Institute of Computing and Cybersystems. The ICC (icc.mtu.edu) is the research arm of the University's new College of Computing, which opened July 1, 2019. In this role, Havens will work to stimulate and enable research, not only for the ICC and College of Computing, but for MTU as a whole.

During the 2018-19 academic year, **Chee-Wooi Ten** took a sabbatical to catch up on publications, establish new collaborative connections in both industry and academia, and renew his work/life balance in preparation for new funding in 2021 and 2022.

Ten spent six months at Carnegie Mellon University studying the organizational structure of the computer science and engineering programs, as well as the strategy behind the engineering research center. While based in Pittsburgh, Pennsylvania, he also met with entrepreneurs and public authorities across the northeastern US, and conducted seminars at seven universities in the region to promote his cyber-physical system security insurance project.

In addition to his professional activities, Ten dedicated time to his daughter and worked on violin pieces from "Schindler's List," accompanied by his sister on piano. He also enjoyed fishing trips and overall rest during 2018-19.

Promotion and Tenure


Lucia Gauchia


Zhaohui Wang

Lucia Gauchia and **Zhaohui Wang** were promoted from assistant professor to associate professor with tenure. The ECE Department congratulates Professors Gauchia and Wang on this accomplishment, and on all their achievements in research and teaching.

Left to right: Trevor Boal (ME-EM '19), Darrell Robinette (faculty advisor, ME-EM), John Gohl (GM mentor, EE '02), Akhil Kurup (graduate student, ECE), Joe Rice (graduate student, CS), Derek Chopp (graduate student, ECE), Nate Spike (graduate student, ME-EM), Jeremy Bos (faculty advisor, ECE), Angela Xydis (ME-EM '19)

AutoDrive Challenge 2019

Michigan Tech's Team Prometheus Borealis finished fourth overall at the second year-end competition of the AutoDrive Challenge in Ann Arbor, Michigan. The team placed second in the Pedestrian, Mathworks, and Cost-Effectiveness Challenges, and took home the second-most awards of any team.

Prometheus Borealis is one of eight collegiate teams in North America participating in the inaugural AutoDrive Challenge, hosted by SAE International in partnership with General Motors. Participants in the multiyear competition convert a Chevrolet Bolt into an SAE Level 4 autonomous vehicle, meaning it can drive itself in most environments with little or no human intervention.

The Michigan Tech team comprises 40 students from multiple disciplines in the Robotic Systems Enterprise, hosted in the ECE Department. The team is advised by Jeremy Bos, assistant professor of ECE, and Darrell Robinette, assistant professor of mechanical engineering-engineering mechanics (ME-EM).

Bos said Team Prometheus Borealis walked away from the competition feeling pretty good. Despite intense competition, they were within range of second place—even considering the resource advantage some of the other competitors enjoy.

"The second and third place teams also admitted that if they had completed their dynamic runs before us, we would have easily made second place," said Bos. "They learned from our success. Who ran when was a big factor in the competition last year. Fortunately, the organizers have made changes for year three so run order will no longer be a factor."

Bos is enormously proud of the team. "Our success really speaks to the tenacity, resourcefulness, and commitment of our students," he said. "To that point, a graduating senior, Trevor Boal (ME-EM), worked continuously past final exams on our second-place Mathworks challenge project. We also had the only 'perfect' run of any team during any dynamic event."

The perfect run was the team's second attempt, so they only received half the points—but it got a reaction. "The organizing committee was cheering when we finished," said Bos.

The commitment of the team's graduate students—Derek Chopp (ECE), Akhil Kurup (ECE), and Nate Spike (ME-EM)—is another big part of the team's success. "They make themselves continuously available to our students while still maintaining a high level of research activity," said Bos. "Most of our success can be attributed to their support, commitment, and all of their late nights."

The team's next challenge will be the third year-end competition in October at the Transportation Research Center in East Liberty, Ohio.

"Fortunately, we are expecting to bring on another graduate student," said Bos, "and having the competition in the Robotic Systems Enterprise provides us with a significant advantage over the other teams."

In Prometheus Borealis's first year, students developed and implemented their vehicle design in Houghton and spent spring break road-testing the vehicle at Road America in Elkhart Lake, Wisconsin. In the first year-end competition at the GM Proving Grounds in Yuma, Arizona, the team placed second in Concept Design.

The AutoDrive Challenege was launched as a three-year competition. However, SAE recently announced it will be extended for a fourth year.

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By Kelley Christensen

A Visit from the Small Business Administration

In July 2019, Chris Pilkerton, general counsel to the US Small Business Administration and for a time its acting administrator, visited Calumet Electronics, and then presided over an hour-long meeting in Michigan Tech's Memorial Union Building, attended by about 40 representatives of education and business.

>>>Read more about his visit and Michigan Tech alumna Audra Thurston '18: mtu.edu/news/stories/2019/july/a-perfect-example-alumnas-story-told-at-round-table.htmls

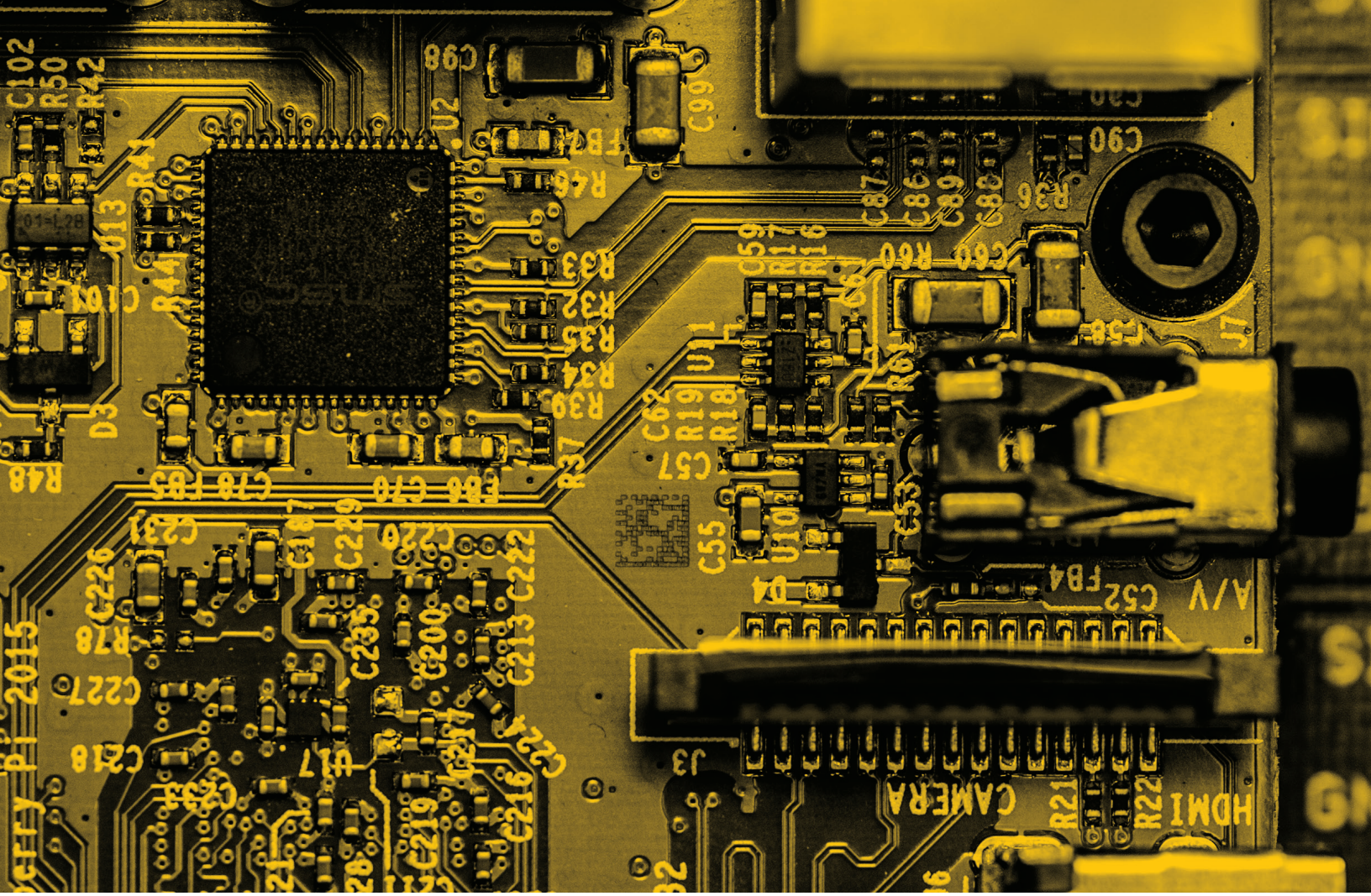
Chris Middlebrook, associate professor, developed a printed circuit board (PCB) class to enrich the Michigan Tech Department of Electrical and Computer Engineering's manufacturing design offerings. The course, EE2230/2231: Printed Circuit Board Fabrication, offers students the chance to create their own multilayer printed circuit boards, connects students to industry, and ensures the ongoing future of PCB manufacturing.

"The overarching idea is that there's the class, but there is also the bigger picture: to develop a curriculum, a specialty concentration, a focus on electronic design and manufacturing," Middlebrook said. "The electronics manufacturing design area has a retiring workforce and they are in desperate need of new talent. And within the Midwest region there is a lot of industry that does that kind of work and looks for graduate hires."

During the course, which becomes available to Michigan Tech students in their second year, students work together in pairs to create a multilayer printed circuit board, from the initial layout to the final inspection and testing.

"The course gets students involved and excited about electronics manufacturing and design. It gets them excited early," Middlebrook said.

> "It's a heavy fabrication course, very hands-on, which is not a hard sell to Michigan Tech students—our students want to learn how PCBs are manufactured."
>
> **Chris Middlebrook**
> Associate Professor of Electrical and Computer Engineering



"It's a heavy fabrication course, very hands-on, which is not a hard sell to Michigan Tech students—our students want to learn how PCBs are manufactured," he added.

The course was first offered as a trial two years ago and filled quickly. Numerous guest speakers are lined up during the semester to speak about the various aspects of design, manufacturing, and testing within the entire gamut of electronics manufacture. Middlebrook notes that even for the students who ultimately don't go into PCB manufacturing specifically, the course makes them better engineers by imparting an understanding of the entire PCB manufacturing process.

"With manufacturing going down in the US, this is an effort to keep that process in-country," he said. "It's more than the class. There's a greater effort, a greater meaning."

MTU's PCB Efforts Supported by Industry

Middlebrook says a number of companies have taken notice of the PCB course and have responded by donating materials.

Leadership at Plexus, a product realization company based in Neenah, Wisconsin, realized that Michigan Tech students accept Plexus offers for employment at the highest rate of any university, and recently donated funding to the ECE Department to develop an electronics-focused makerspace in the Electrical Energy Resources Center (EERC).

Altium, a company that produces software for PCB designers, has donated 20 licenses for a high-level design software package for student use. Additionally, Judy Warner, Altium's director of community engagement, interviewed Middlebrook for Altium's OnTrack podcast about the course.

MTU Student Elected as IPC Student Liaison

IPC, a PCB standards-setting professional organization, started establishing student chapters at universities around the country several years ago—and Michigan Tech's chapter was the first. Paige Fiet, a third-year student studying electrical engineering, biomed applications, was elected to the IPC board of directors as the student member liaison. Fiet is also a process engineering intern at Calumet Electronics, an IPC member.

>>>Read more about Michigan Tech's IPC chapter at: involvement.mtu.edu/organization/ipc-electronics

FACULTY PROFILE

Professor Mike Roggemann

Professor Mike Roggemann's research specialties—image reconstruction and processing, pattern recognition, and adaptive and atmospheric optics—are applied in today's workforce to solve problems involving atmospheric turbulence and laser communications, also called laser comm.

"Most people working in these fields now work in the aerospace industry," said Roggemann. "However, free space optical comm is gaining traction in the commercial world."

Roggemann, who joined Michigan Tech's faculty in 1998, has been singled out by his colleagues for his open mind when it comes to online courses. From his perspective, there are both advantages and disadvantages to online delivery.

"As a means of directly transporting the professor's expertise to the computer and putting it in front of students, it's pretty powerful," he said. "The drawbacks are that both students and professors have to work harder to communicate. It's also harder to convey the professor's experience, judgement, and ethics online."

"Particularly for grad students, online delivery can be tailored to merge with careers and family life, and this is another powerful argument for doing it well," he continued. "In the end, online delivery is now part of the fabric of education in this country, and we need to strive to 'be all we can be' in delivering the highest quality education we can."

And the quality of a Michigan Tech education is a big draw for both undergraduate and graduate students, according to Roggemann.

"Undergrad and grad students get the same pitch," he said. "Michigan Tech is big enough to cover a lot of intellectual territory and small enough to be able to really interact with your professors. The institution is deeply invested in hands-on education and lots of practical practice."

"The institution has created a culture of excellence in teaching that has never wavered in my 22 years at Michigan Tech, and I expect it will remain so long after I'm retired," he added.

FACULTY PUBLICATIONS

Journal Articles and Selected Conference Publications

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FACULTY PUBLICATIONS

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BEHIND THE SCENES

By Kelley Christensen

Mark Sloat, ECE research associate, aids faculty and students in the lab and with fabrication and design. Though his work happens behind the scenes, it is by no means a minor contribution.

In addition to serving as the safety liaison for ECE Department, Sloat maintains and repairs laboratory equipment in undergraduate and research labs, fabricates printed circuit boards for undergraduate and research programs, and assists students with electrical/electronic design in Senior Design and Enterprise programs.

Recently, he helped prepare the Oculus-ASR nanosatellite, which launched from Cape Canaveral Pad 39A aboard the SpaceX Falcon Heavy in June 2019, for environmental testing at Kirtland Air Force Base. His work helped ensure the viability of the flight controller onboard Oculus. To hear Sloat tell it, what he did was minimal, but others in the ECE Department are quick to note how critical his contribution was.

In summer 2017, the Aerospace Enterprise student team learned they had just a few weeks to finalize on-campus work on the nanosatellite before it was sent for environmental testing. Sloat helped to wrap up the wiring and testing in the clean room. He also did the surface mount soldering of the flight controller circuit board and the solar panel charging system on the nanosat, which required a microscope and a soldering iron with an incredibly fine tip.

In addition to his work with the Aerospace Enterprise team, notable projects Sloat has worked on in the past two years include designing an open-source, programmable battery management system for research that would eventually earn Michigan Tech assistant professor Lucia Gauchia an NSF CAREER Award. The controller allowed a lithium-ion battery cell to simulate how an alternative energy source, like a solar panel or wind turbine, would charge the battery and then how a typical household load would feed from the batteries.

Another noteworthy project Sloat undertook was designing a second graphitization rig for the Carbon, Water and Soils Lab housed in the USDA Forest Service (USFS) Northern Research Station in Houghton. The station is the graphitization lab for the Radiocarbon Collaborative, a partnership between Michigan Technological University, USFS, and the W.M. Keck Carbon Cycle Accelerator Mass Spectrometer Facility at University of California–Irvine.

>>>Read more about the Oculus-ASR launch: mtu.edu/magazine/research/2020/stories/oculus/

>>>Read more about the Radiocarbon Dating lab: mtu.edu/unscripted/stories/2019/january/radiocarbon-dating.html

STAFF PROFILE

> I am always impressed with how much our students can accomplish in such a short time frame.

Research Associate Mark Sloat

Research associate **Mark Sloat** has made some memories in Michigan Tech labs.

Sloat's presence in teaching labs is usually to investigate a malfunction, restock components, or assist a teaching assistant (TA). But during a 555 timer circuit lab, he was nearby when one particular student called the TA over to sign off on his circuit. As the TA arrived, the circuit stopped working.

"The student quickly replaced the 555 timer IC and said, 'See, it works. Sign my sheet quick!'" said Sloat. "The circuit again stopped working, and again the student replaced the 555 timer IC. The TA looked down at the circuit, as well as the small pile of burned 555 timers and charred resistors, and said the student's circuit should not draw 1 amp. The student replied, 'I think it just needs a heat sink.'"

Sloat said other memorable experiences happen as part of two undergraduate labs where students design their own printed circuit boards.

"I see the finished designs just before I mill the boards on one of our circuit board routers," he said. "I am often amazed by how small some of our students make their boards using rather large through-hole components. When a certain lab section has multiple 'tiny' boards, there is a friendly rivalry going on, and that is where the talent shines through."

From the research lab, one of Sloat's favorite projects was helping associate professor Lucia Gauchia design and build modular battery management systems capable of expansion of a larger-scale system.

"A design was developed and 25 of these management systems were constructed and tested individually," he said. "Our fabricator, Mike Goldsworthy, created a partitioned rack system to house the individual battery controllers and to ensure safety. The software fell to Dr. Gauchia's students."

Several algorithms needed to be modeled, such as wind and solar energy storage and depletion, and automotive regenerative braking.

"The students asked questions to understand the hardware and ran with it," he said. "Within a year, they had a full working system pouring data into a server for analysis."

Sloat spends most of his time in the undergraduate programs, and a big part of that time is providing technical support, logistics, and fabrication for Senior Design and Enterprise groups.

"I am often approached by students from all disciplines with questions regarding their project designs," he said. "We are very fortunate to have smart and inquisitive students—most of the time they ask for help, soak up and process that information, and return with some follow-up questions or a working model."

Seeing the students turn a pile of parts and components into a "working something" is particularly rewarding.

"I am always impressed with how much our students can accomplish in such a short time frame," said Sloat. "Students today have so much going on in addition to their academics, such as outreach, community support, career preparation, and part-time jobs. It's easy to see their Enterprise and Senior Design projects get pushed back into the spring semester, but the groups always seem to band together and get the project done."

NEW STAFF

Megan Jarvi joined the ECE Department as graduate program coordinator in April 2019. In this administrative role, the Department's graduate students are her primary focus. Her goal is to make their time at Michigan Tech go as smoothly as possible, helping with graduate student payroll and sending forms to the Graduate School.

"I really enjoy working with the students," said Jarvi. "Watching them succeed and helping them do that brings so much joy to me."

Jarvi came to Michigan Tech from Apirus Keweenaw Hospital, where she worked for five years as a health information specialist. She holds an associate's degree in business administration and is currently pursuing a bachelor's degree in financial planning. And to say she's happy to have joined the Department might be something of an understatement.

"I remember going to Tech for Take Your Daughter to Work Day with my mom during elementary school," she said. "I always wanted to follow in my mom's steps and get a job at Michigan Tech. That dream came true when I joined the ECE Department last April."

Outside of Michigan Tech, she has an interest in the outdoors and enjoys spending time with her family. In her opinion, the best part of living in the Copper Country is the people.

"I love how the Copper Country comes together in a time of need," she said. "We are a small community and I am so proud to be a part of it."

Maryann Wilcox is the ECE Department's new office manager/technical communications specialist. In this position, she handles "anything and everything that pertains to the operations of the Department."

Although she only recently joined the Department, Wilcox has been with Michigan Tech for more than 20 years. She said this job is a perfect fit for her.

"I had heard through the grapevine that ECE was a great place to work and felt that this particular position encompassed every job experience I've had at the University and everything I studied as an MBA student," she said. "I was hesitant to apply—it was too good to be true—but my academic advisor told me, 'You can't hit the ball unless you go to the plate and swing.' The rest is history."

"The best part of this job is working with the amazing faculty, staff, and students, and knowing that I am an integral part of the Department and my work is valued," she said. "The biggest challenge is fitting it all into a reasonable work week and making sure each person who comes to my door knows they are my new top priority."

Wilcox, who loves to walk, said the Copper Country has plenty of places to walk or hike. And, there's a lot she loves about the area, from the fresh air and water to the people.

"I love the Yooper values of lending a hand, generosity, checking in on your neighbor or someone stranded on the highway, and hospitality," she said. "I love it that many Yoopers carry a tow strap in their truck and aren't afraid to use it."

Staff Directory

Judy Burl	ECE Undergraduate Advisor	**Chito Kendrick**	Managing Director, Microfabrication Facility
Liz Fujita	CpE Undergraduate Advisor (current)	**John Pakkala**	Graduate Academic Advisor
Michael Goldsworthy	Research Associate (joint with MMET)	**Chuck Sannes**	Laboratory Supervisor
Trever Hassell	CpE Undergraduate Advisor (2018-19 academic year)	**Mark Sloat**	Research Associate
Megan Jarvi	ECE Graduate Program Coordinator	**Maryann Wilcox**	Office Manager/Technical Communications Specialist
Michele Kamppinen	Office Assistant		

GRADUATE STUDENT AWARDS

ECE Fellowships 2018-19

Wyatt Adams
John Miles Endowed Fellowship

Mohamed Ait Mhamed Belcaid
Fulbright Scholar

Ian Cummings
NSF Graduate Research Fellowship

Zachary Jeffries
Michigan Tech Representative for CGS/ProQuest Distinguished Dissertation Award

Akhil Kurup
James and Marlene Fugere Fellowship

Devalkumar Thakar
Michigan Tech Representative for CGS/ProQuest Distinguished Dissertation Award

Jingyuan Wang
Graduate School Finishing Fellow

Sakineh Yazdanparast
Graduate School Finishing Fellow

ECE Doctoral Degrees: Summer 2018 to Spring 2019

PhD Graduate	Advisor(s)	Major	Dissertation Title
Casey Demars	**Michael Roggemann**	Electrical Engineering	Target Detection, Tracking, and Localization Using Multi-Spectral Image Fusion and RF Doppler Differentials
Arash Hosseinzadeh	**Christopher Middlebrook**	Electrical Engineering	Linear Ring Resonator Modulator for Microwave Photonic Links
Paniz Hazaveh	**Paul Bergstrom and John Jaszczak**	Electrical Engineering	Generalizable Modeling of Charge Transport in Single Electron Transistor Devices: Application to Thermal Sensitivity in Semiconducting Island Systems
Aref Majdara	**Saeid Nooshabadi**	Electrical Engineering	Offline and Online Density Estimation for High-Dimensional Data
Ronald Matthews	**Wayne Weaver**	Electrical Engineering	Power Flow Control in Hybrid AC/DC Microgrids
Mehrzad Bijaieh	**Wayne Weaver**	Electrical Engineering	Energy Storage Control and Requirements for Inverter-Based Microgrids
Navid Gandji	**Elena Semouchkina**	Electrical Engineering	Employing Dielectric-Based Media for Controlling Field Patterns and Wave Propagation in Advanced Electromagnetic Devices
Yachen Tang	**Chee-Wooi Ten**	Computer Engineering	Anomaly Inference Based on Heterogeneous Data Sources in an Electrical Distribution System
Chaofeng Wang	**Zhaohui Wang**	Electrical Engineering	Intelligent and Secure Underwater Acoustic Communication Networks

MTU'S BLUE MARBLE FINDS A BETTER WAY FOR FORD

Students at Michigan Technological University have engineered a solution that will save Ford Motor Company hundreds of thousands of dollars—and it started with a casual hallway conversation.

A couple of years ago, Glen Archer, interim chair of the ECE Department, bumped into Paul Sanders, the Patrick Horvath Endowed Professor of Materials Science and Engineering (MSE). "Is Blue Marble looking for a project?" Sanders asked.

Blue Marble Security, one of Michigan Tech's Enterprise programs, is a virtual company made up of undergraduate students focused on securing the future through thoughtful use of technology. Archer is the group's advisor.

The project was straightforward. Ford's Research and Innovation Center needed a way to adapt an older-model JEOL 6300 scanning electron microscope (SEM) to use a modern display.

A former colleague of Sanders, James Boileau, runs the materials characterization lab at the center. Like Sanders, Boileau is a metallurgist who routinely submits proposals to the Poling Prize, funded by the family of former Ford president, the late Harold Arthur "Red" Poling. And, Boileau was looking for an engineering team for his JEOL 6300 proposal.

Ford's JEOL 6300 SEM is similar to the JEOL 6400 at Michigan Tech. These SEMs use monitors with cathode ray tubes (CRTs), which are essentially old-school TV tubes. CRTs are expensive and hard to find, their disposal is environmentally hazardous, and JEOL was running out of spare monitors for Ford's 6300.

Blue Marble went to work. The goal was to replace the CRT monitors with off-the-shelf LED displays, but success didn't come early or easy. The project spanned two academic years.

The first attempts involved examining the CRT video signals. "The first year's attempt produced some partial success in the sense that the students diligently uncovered a number of solutions that wouldn't work very well," Archer said with a smile. "I ruled this effort unsafe because of the high voltages involved and told the students to look deeper into the system to find the video signals while they are still at safe levels."

The second year brought new leadership and insights, and eventually complete success. The students were given access to Tech's JEOL 6400. In addition, Owen Mills, senior research engineer and director of the Applied Chemical and Morphological Analysis Laboratory in the MSE Department, provided printed schematics, operations, and maintenance manuals.

The search for a place to tap the video signals required the visual inspection and searching of hundreds of pages of printed schematics before Blue

Marble found what they were looking for: a low-voltage signal in an early video display protocol pioneered by IBM—a monochrome display adapter (MDA).

Next came the delicate process of examining the signal characteristics. The test protocols were reviewed by Archer and Mills, and the team's efforts had paid off. "In the end, the video signal was available and adaptable to modern display protocols with a low-cost, commercial off-the-shelf adapter," Archer said.

The students designed a case for the new monitor and were able to 3D-print it at the University's library. The total system cost is less than $100.

After taking their final exams in April 2019, several members of Blue Marble drove to Boileau's lab in Dearborn, Michigan, and installed the monitor on his JEOL 6300 in about two hours. The project team also ordered the parts to produce a similar adapter for Michigan Tech's JEOL 6400, and that installation took place last fall.

The timing of the installation was perfect, as one of the monitors on the 6300 was beginning to lose contrast, limiting its use.

"The project is a complete success for both Michigan Tech and Ford," said Boileau. "Having a clear image on a large monitor not only restores the system to full use but makes seeing the images much easier. The fact that any PC monitor can be used with the Michigan Tech adapter means that the SEM will be able to be used for years to come."

"This is why we chose Michigan Tech," he added. "We get access to outstanding engineering talent that maximizes a project's chance of success."

> "This is why we chose Michigan Tech. We get access to outstanding engineering talent that maximizes a project's chance of success."

ECE Undergrad Cameron Philo Wins Best Technology Venture

Michigan Tech electrical engineering undergraduate student **Cameron Philo** won Best Technology Venture at the ninth annual New Venture Competition, held at Central Michigan University on April 12, 2019.

Philo was awarded $10,000 for his winning startup, Life Pro Jackets, after presenting his business plans and pitch to panels of experienced entrepreneurs.

Philo's design was inspired by a family's fatal kayaking trip.

"A family of four went kayaking on Lake Superior and their boats tipped," said Philo. "Only the mom came back because the water was so cold. When I heard the story, I thought, 'They were doing everything right, they were wearing life jackets, but it still wasn't enough.'

"It got me thinking: for people who are taking the right steps and precautions, how can we make sure it's always safe for them to come back? So, I came up with a way to put some heating elements into a life jacket to prevent hypothermia and put GPS tracking into it so the wearer can trigger it and alert first responders."

Talking with first responders and water enthusiasts and considering water safety factors helped Philo further define the problem.

"We noticed there are a lot of bodies of water that don't get very warm. The problem with that is people can quickly develop hypothermia," Philo said. He also noted that, as pointed out by first responders, when someone falls out of a boat on the water, the boat may float away from the person, making search and rescue more difficult. "That's where the GPS comes in," he said.

Philo worked with teammates and fellow undergraduate students Jacob Formolo (biomedical engineering) and Jared Harber (materials science and engineering) to share and build on their ideas. They considered the installation of either chemical or electrical heating elements, as well as manual or automatic triggering of GPS with water or temperature-pressure sensors.

Philo also studied Coast Guard data to calculate water temperatures and lengths of time someone could safely stay in the water.

Philo then demonstrated his idea for its intended user and received feedback to improve the designs—and he did this over and over. He participated in on-campus activities and a local effort, "1 Million Cups," pitching his idea to diverse audiences for feedback and suggested resources.

His efforts resulted in a life jacket with technology that provides more safety without requiring the user to, as Philo puts it, "wear a ton of stuff."

Philo participated in Michigan Tech's I-Corps Site Program in fall 2018. The program, a partnership between the National Science Foundation (NSF) and Silicon Valley entrepreneurs, emphasizes "lean startup" principles and customer feedback. During the four-week program, students test their ideas outside the lab and in at least 30 face-to-face interviews with potential customers and partners from target markets.

Michigan Tech is one of 100 designated NSF I-Corps sites in the country.

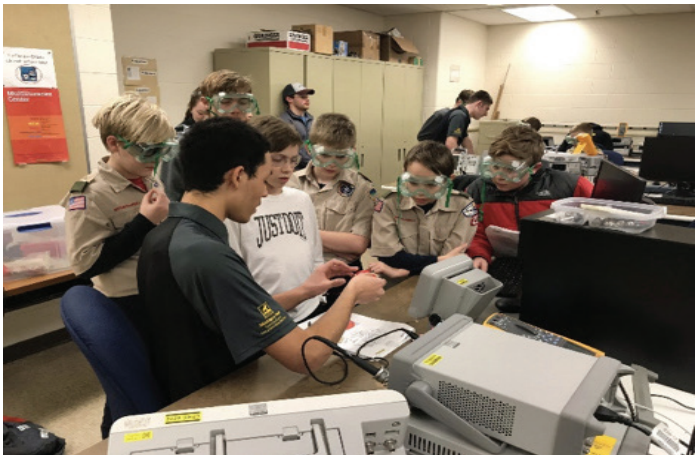
SENIOR DESIGN

This year's Larry Kennedy Industry Innovation Award went to the Hard Surface Disinfectant Prethread and Automation team. Pictured (L-R) are advisor Trever Hassell and team members Chris DeWidt, Jacob Erickson, Clinton Andrews, and Stefan Koerner. Not pictured is team member Drew Wilkerson.

2018-19 Senior Design Teams

Project	Sponsor	Advisor
Microfabrication Facility Support	ECE Department	Tony Pinar
Boat HUD	ECE Department	Tony Pinar
Automated Functional Testing Device for Logic Devices	SERC Capstone Marketplace	Trever Hassell
Automated Functional Testing Device for Operational Amplifiers	ECE Department	Aref Majdara
Cancer Detection	ECE Department	Aref Majdara
Personnel Recovery Power	SERC Capstone Marketplace	John Lukowski
Hard Surface Disinfectant Prethread and Automation	Rockline	Trever Hassell
Remote Substation Power	ITC	John Lukowski

BMS Teaches Through-Hole Soldering



Blue Marble Security hosted two heart rate monitor soldering events in November 2018, welcoming the Society of Women Engineers (SWE) to the lab on November 9 and local Boy Scouts on November 27. Sixteen SWE members and around seventeen Boy Scouts attempted to build their own heart rate monitor board within the time limit, with assistance and supervision from BMS members and their advisor.

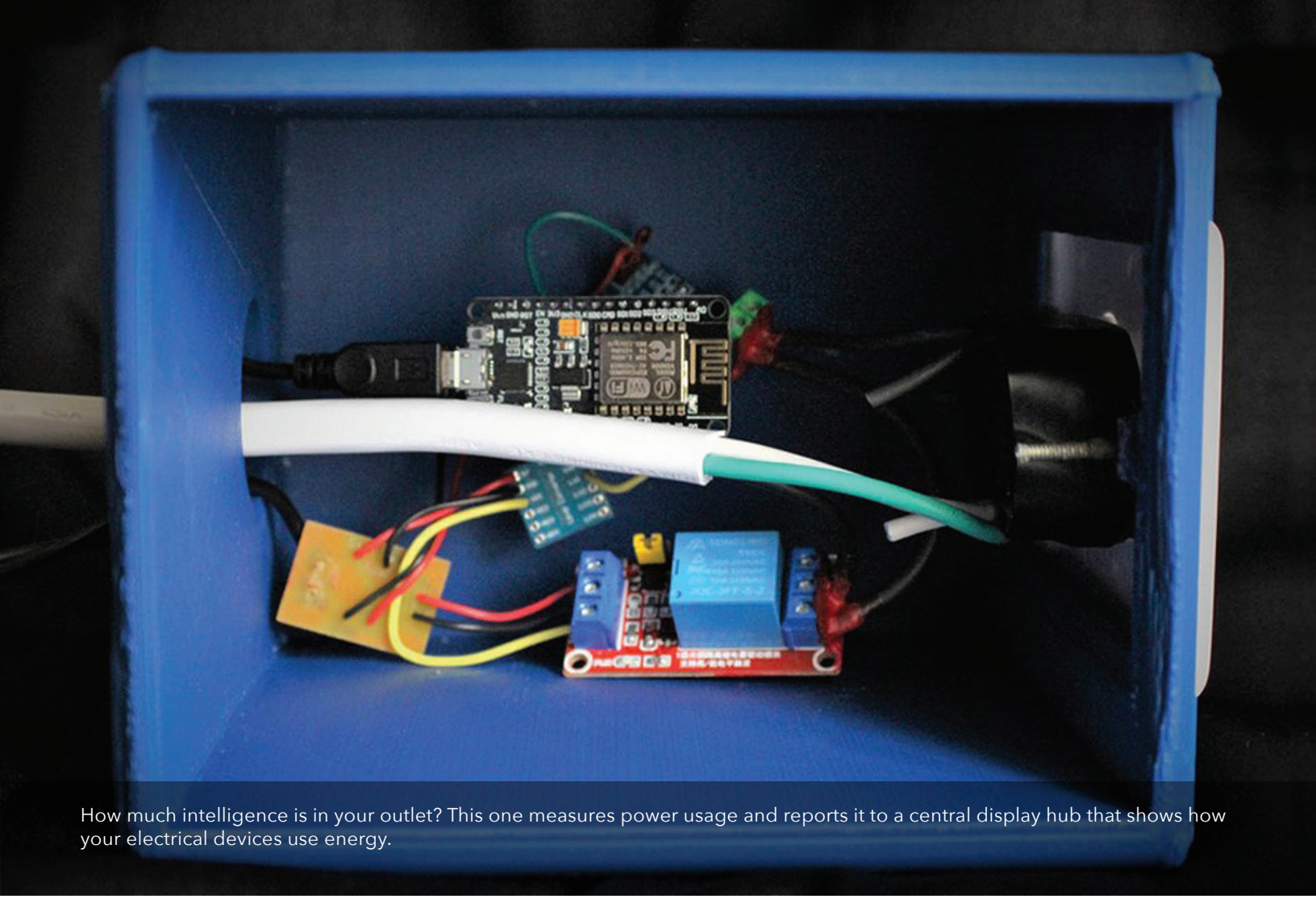
The events taught the basics of electrical engineering components. Concepts discussed included how the color bands on resistors correspond to the resistors' value and the polarity of diodes and the importance of placing them correctly. However, the lab's main focus was learning to through-hole solder appropriately for strong connections on the board. Once fully soldered with correct connections, LEDs on the heart rate monitor blinked with the operator's heart rate.

All participants took home a heart rate monitor board as a souvenir.

Blue Marble Security Enterprise 2018-19

Advisor: Glen Archer

Project	Sponsor
Cost Effective Vision Pick Point System: Developing a cost-effective vision pick point system using commercial, off-the-shelf components	General Motors
Proprietary CRT Retrofit to Modernize Scanning Electron Microscope Display: Building an adapter for a scanning electron microscope that will display the output from the machine on a modern computer monitor	Ford Motor Company
BMS Outreach: Growing interest in STEM, the ECE Department, and Michigan Tech through outreach to local youth	ECE Department
Predictive Failure of Steel Galvanizing Line: Analyze and interpret data collected by ArcelorMittal on their galvanizing process to successfully predict an oncoming line stop event	ArcelorMittal
Amphibious Side by Side: Designing a vehicle that can be carried on a boat or aircraft; be launched; traverse open ocean, surf, and beaches; and provide off-road or cross-country mobility for two to four operators	SERC
Army Backpack: Designing, testing, and prototyping battery technologies	SERC
Autonomous Robot: Designing, building, and programming an autonomous vehicle that can successfully compete in the Intelligent Ground Vehicle Competition	ECE Department



How much intelligence is in your outlet? This one measures power usage and reports it to a central display hub that shows how your electrical devices use energy.

Wireless Communication Enterprise 2018-19

Advisor: Kit Cischke

Project	Sponsor
Broomball website: Refreshing the electronic scoreboards and an overhaul of the broomball website	ECE Department
Sweet sound: Developing a DSP system for Visual and Performing Arts students to use in their loudspeaker design class	ECE Department
Bluetooth speaker: Designing a Bluetooth speaker with pulsing LEDs based on a frequency analysis of the music	ECE Department
Wi-Vi: Working with a software-defined radio platform to develop a wireless video solution	ECE Department
HOTAS radio control: Developing an engineering prototype of a new interface for military pilot communications	SERC
Ford smart charge: Developing a more efficient way to charge electric vehicles at multivehicle charging kiosks	Ford Motor Company
Ford smart home energy management system: Developing a home energy dashboard and energy storage system	Ford Motor Company

UNDERGRADUATE STUDENT AWARDS

Sam Solverson
2019 ECE Departmental Scholar

Katelyn Rhue
2019 ECE Woman of Promise

Lucas Simonson
2019 Carl S. Schjonberg Outstanding Undergraduate Student

External Advisory Committee

The goal of the External Advisory Committee is to ensure the ECE academic program aligns with industry to produce graduates with skills desired by today's companies. Each year at their spring meeting, the EAC members–volunteers from many different industries–observe ECE's Senior Design and Enterprise team presentations and poster displays. They select the team showing the highest level of project management, applied engineering, and application to industry to receive the Larry Kennedy Industry Innovation Award.

David Aho
Eaton Cooper Power Systems

Ellen M. Bauman
IBM

Keith Behnke
Stryker Instruments

Brent Carlson
3M Engineering

Anthony Champagne
Nexteer Automotive

Rob Cooke
Calumet Electronics

Jonathan Doane
MIT Lincoln Laboratory

Ben Galloway
Dematic Corporation

Brett Giem
Chrysler Technology Center

Gordon (Gordie) Halt
ITC Holdings

Steve Kennell
Retired

Kurt LaFrance
Consumers Energy

Eric Larson
3M Corporate Research

Ken Leisenring
Ford Motor Company

William Lepak
ArcelorMittal

Steve S. Mathe
Harris Corporation

Heidi Mueller
Ford Motor Company

Tim Obermann
Milwaukee Tool

David Perry
Retired

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

Nirmal Singh
Detroit Edison

Jeff Wells
Retired

ECE's Learning Center Renovated, Renamed

Thanks to a $75,000 gift from ITC Holdings in 2018, the ECE Department now offers undergraduate students a bright, well-equipped, modern space to study together and participate in peer mentoring.

The newly renovated ITC Learning Center—formerly the ECE Learning Center, and renamed in honor of the gift—is a 560-square-foot room adjacent to the ECE Department office and near two large lecture halls. The center is used for student collaboration, mentoring with learning center coaches, and as a place for students to work on homework and socialize between classes and in the evening.

The renovated room meets modern technological standards as a collaborative and mentoring workspace. It received an overall facelift with new carpeting, paint, and glass whiteboards. The space was redesigned around sets of tables and chairs, with one of those allowing students to connect laptop computers to a 65-inch wall-mounted monitor. The enhanced functionality and attractiveness of the space is expected to increase utilization and strengthen the sense of community among ECE students.

Dan Fuhrmann, former ECE chair, was "delighted" by ITC's generosity. "The Department has needed to upgrade this resource for our students for quite some time," he said. "It's nice that students have a place to hang out and work so close to their classrooms, but now they will have a brighter, cleaner space that is more inviting and more conducive to collaborative learning. I'm sure more students will take advantage of it once they learn what we have done."

ITC, an electrical power transmission utility headquartered in Novi, Michigan, has a long and positive relationship with Michigan Tech's ECE Department and College of Engineering.

Jon Jipping, ITC's executive vice president and chief operating officer, was instrumental in arranging the gift. Jipping was chair of the ECE External Advisory Committee at the time, and is currently chair of the CoE External Advisory Board. "At ITC, we recognize the importance of inspiring today's students to pursue careers in engineering, which is critical to the future of our industry," Jipping said. "The renovated ECE Learning Center will offer an environment where students can be inspired, collaborate, and advance their educational pursuits."

In recognition of ITC's support for the ECE Department over many years, and for this gift specifically, the ITC Learning Center will bear the company's name for the next five years, and will feature appropriate signage and displays.

CONTRACTS AND GRANTS

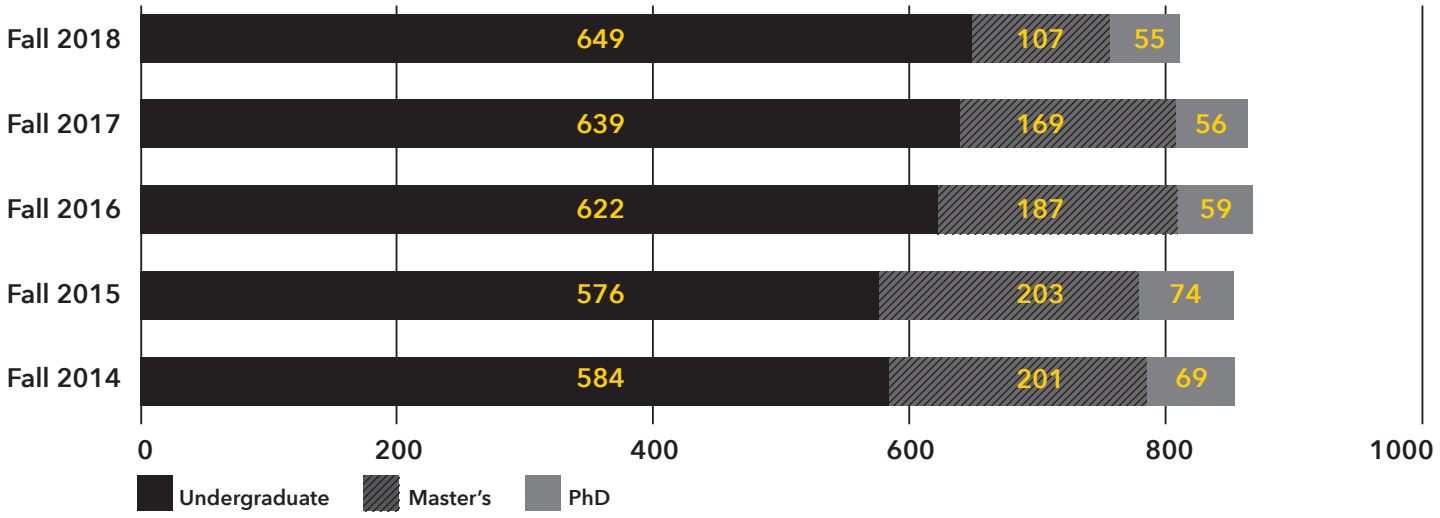
Engineering research and development are key to technological progress and economic revitalization, and the ECE Department at Michigan Tech is busy doing its part. Our faculty, graduate students, and undergraduates work together in modern, well-equipped laboratories to bring practical solutions to real-world problems in signal processing, wireless communications, computer-aided design, energy systems, electronic materials and devices, photonics, and much more. We are eager to tackle new challenges and are always looking for new opportunities that are well matched to the interest and expertise of our faculty.

ECE Contracts and Grants Awarded: Fiscal Year 2019, July 2018 to June 2019

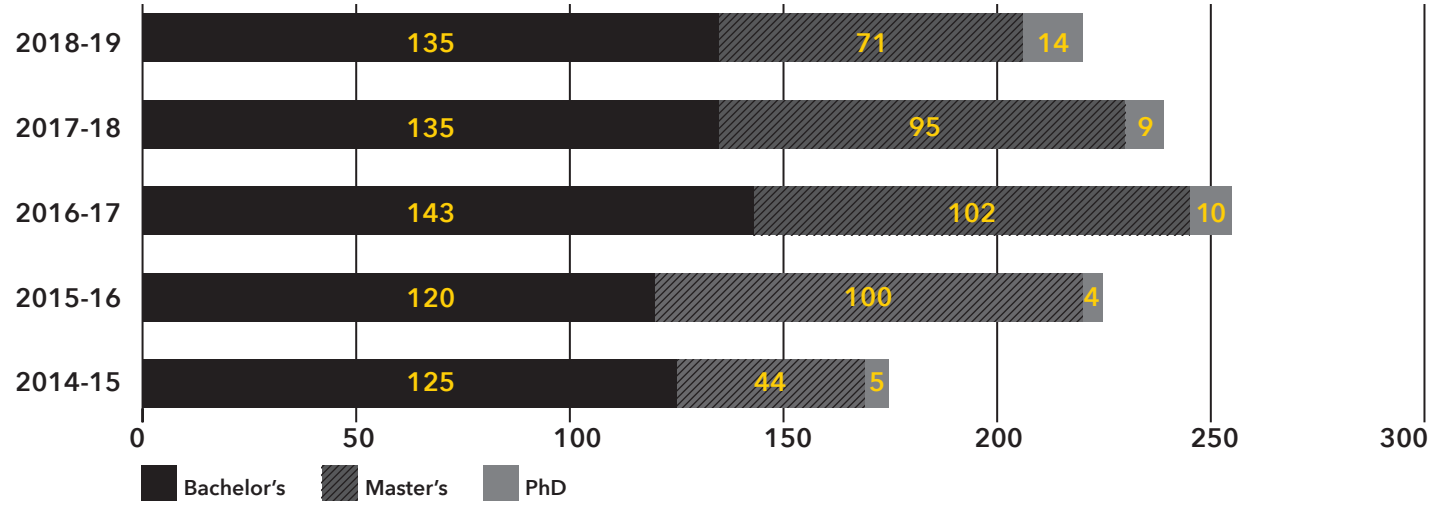
Title	Sponsor	Sponsor	Award
Enterprise: Oshkosh Baja LCV Suspension Design - Phase II	Glen Archer	Oshkosh Defense LLC	$8,500
Enterprise: SERC 2018 Army 01 Novel Back-packable Power Sources	Glen Archer	Stevens Institute of Technology/ US Department of Defense	$5,000
Enterprise: SERC NSW 05 Amphibious Side by Side Vehicle	Glen Archer	Stevens Institute of Technology/ US Department of Defense	$5,000
Imaging Theory and Mitigation in Extreme Turbulence-Induced Anisoplanatism	Jeremy Bos	US Department of Defense	$213,419
Robust Terrain Identification and Path Planning for Autonomous Ground Vehicles in Unstructured Environments	Jeremy Bos	University of Michigan/ US Department of Defense	$151,964
Enterprise: Phase III - Smart Charging EV App Development	Christopher Cischke	Ford Motor Company	$15,000
Enterprise: SERC 2018 AFSOC 03 HOTAS Radio Control	Christopher Cischke	Stevens Institute of Technology/ US Department of Defense	$5,000
Enterprise: Smart Home Energy Management System Interface	Christopher Cischke	Ford Motor Company	$15,000
Graduate Research Fellowship	Ian Cummings	National Science Foundation	$46,000
SHF: Small: Spectral Reduction of Large Graphs and Circuit Networks	Zhuo Feng	National Science Foundation	$500,000
Trailer Angle Detection Using Multiple Automotive Radars	Daniel Fuhrmann	Ford Motor Company	$202,567
Algorithms for Look-Down Infrared Target Exploitation	Timothy Havens	Signature Research Inc./ US Department of Defense	$40,000
Duty Cycle Aggregation and Warranty Mitigation using Customer Usage Data	Timothy Havens	Ford Motor Company	$50,000
NPT-03/04: Localization Tracking and Classification of On-Ice Underwater Noise Sources Using Machine Learning	Timothy Havens	US Department of Defense	$96,643
Microfabrication Facility Services	Chito Kendrick	Microdevice Engineering Inc./ National Science Foundation	$13,228
Sputter Coating for Thin Film Thermocouples	Chito Kendrick	IR Telemetrics Inc.	$5,000
Various Sponsors: Processing Four IDE Wafers	Chito Kendrick	University of Calgary	$1,332
Design Evaluate and Implement Machine Vision Algorithm for DAT Application	Saeid Nooshabadi	Ford Motor Company	$180,000
Machine Vision Trailering	Saeid Nooshabadi	Ford Motor Company	$120,000
Senior Design: SERC AFRL 05 Personnel Recovery- Power	Anthony (Tony) Pinar	Stevens Institute of Technology/ US Department of Defense	$5,000
Senior Design: Hard Surface Disinfectant (HSD) Pre-Thread and Automation	Anthony (Tony) Pinar	Rockline Industries	$17,500
Senior Design: SERC NSW 01 Boat HUD	Anthony (Tony) Pinar	Stevens Institute of Technology/ US Department of Defense	$5,000
Autonomous Microgrids: Theory Control Flexibility and Scalability	Wayne Weaver	US Department of Defense	$250,045
Meta-Stability of Pulsed Load Microgrids	Wayne Weaver	Sandia National Laboratories/ US Department of Defense	$37,400
Power Electronics Design Integration and Component Selection for AquaHarmonics Inc 1:7 Scale Wave Energy Converter Device	Wayne Weaver	AquaHarmonics Inc./ US Department of Energy	$60,000
Real-Time Simulator for Advanced Energy Network Planning Optimization and Control	Wayne Weaver	US Department of Defense	$200,000

DEPARTMENT STATISTICS

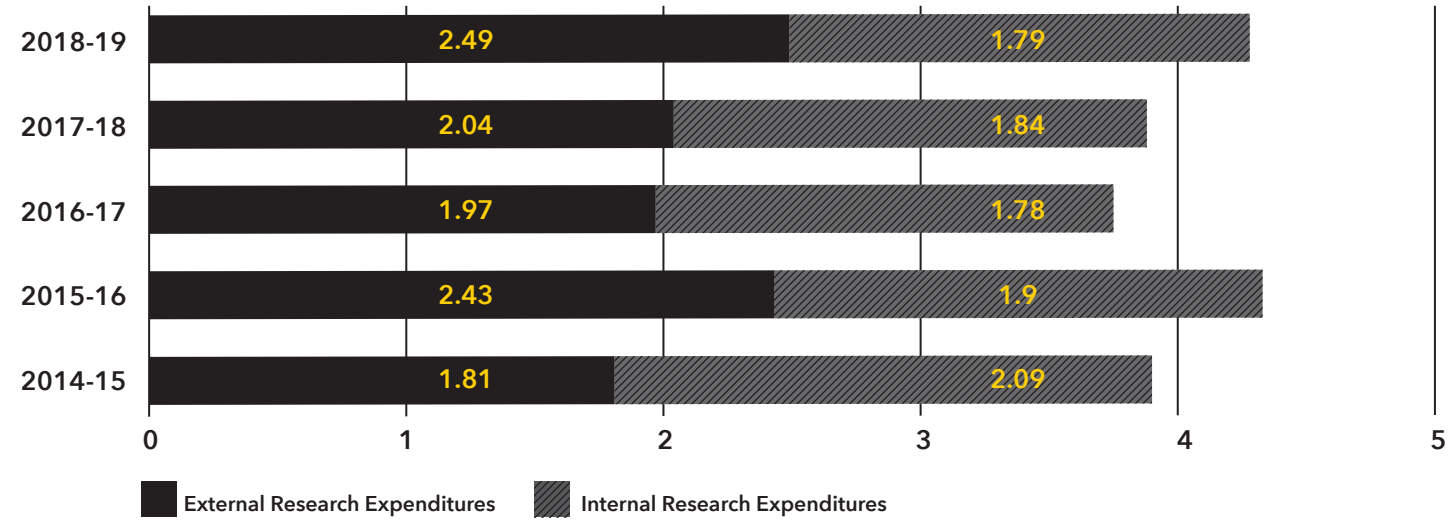
ECE Enrollment



ECE Degrees Awarded



ECE Research and Sponsored Programs (Expenditures in Millions)



Electrical and Computer Engineering

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

An opportunity to give back

Support the electrical and computer engineers of tomorrow with a gift to the Michigan Tech ECE Department. Your generosity improves individual lives and helps build innovative programs that give our students an advantage. All gifts, large and small, are important to the Department.

Tomorrow needs engineers. Tomorrow needs Michigan Tech.
mtu.edu/ece/department/giving

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