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Spring 2016

The Circuit, Spring 2016

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The Circuit

Electrical and Computer Engineering

Spring 2016



In Demand

Every year, more and more companies want to speak with ECE students at Michigan Tech's Career Fairs. Find out why on pg. 10.



From the Chair

*Daniel R. Fuhrmann
Dave House Professor and Chair*

Hello to Huskies everywhere from the faculty, staff, and students of the Department of Electrical and Computer Engineering at Michigan Tech. Welcome to another edition of *The Circuit*, our annual alumni newsletter. In these pages you will find a recap of the major activities and achievements in the ECE department in calendar year 2015. I hope you find things here that pique your interest, make you proud, and maybe even spark a trip back to campus.

In this issue we are highlighting the many career opportunities that our graduates are seeing, as the job market for electrical engineers and computer engineers remains strong. It is something that I have pointed out in this column before, but it bears repeating: electrical and computer engineers from Michigan Tech are in demand. At our Fall 2015 Career Fair, we shattered all previous records for industry participation. We like to think that this has a lot to do with our academic programs, but I also acknowledge that there is a special kind of student who comes to Michigan Tech, and so we have good material to start with. I have to give a shout-out to the Michigan Tech Career Services Office, considered by many of the recruiters as one of the best of its kind in the country. They do an absolutely outstanding job on behalf of our students.

The ECE department believes strongly that

we need to field academic programs and conduct research that is relevant to the needs of society in the 21st century. That means that we need to work collaboratively with others, as a lot of the action these days seems to be at the boundaries of traditional disciplines. In 2014 we launched the Alliance for Computing, Information, and Automation, which brings the ECE department together with the Department of Computer Science and the School of Technology. The Alliance took another step forward this year with the establishment of the Institute of Computing and Cybersystems, Michigan Tech's newest research center. Min Song, chair of the CS Department, is directing the ICC. We are off to a running start with nearly \$2 million in funded research projects. We received a generous gift from the House Family Foundation to bring in some visiting faculty and post-docs, and I am excited to see where that leads.

This year we welcomed two new faculty members to the Department. Aurenice Oliveira joins us as an associate professor from her previous position in the School of Technology. Prof. Oliveira is an expert in performance analysis for optical communication systems. Jeremy Bos, one of our own PhD graduates, returns to the ECE department as an assistant professor after two years as a post-doctoral research fellow

with the Air Force Research Laboratory in Maui; his expertise is in atmospheric optics and imaging. Both Aurenice and Jeremy have expressed a strong interest in branching out into areas of automation and control, which I think is wonderful as I see these as important growth areas for the Department in coming years.

There are a number of other stories in this newsletter on the accomplishments of our faculty and students. We are proud of them and happy for their success. There are also stories about those outside the Department who are the "wind beneath our wings": our External Advisory Committee (EAC) and the many other friends and alumni who support us with their time and treasure. We are deeply indebted to them all.

There is a strong community spirit at Michigan Tech and in the ECE department. I invite you to be a part of that community as well. In an effort to build those relationships we are stepping up our presence on social media, and you can find my random musings in a weekly column called "Fridays with Fuhrmann." <https://blogs.mtu.edu/ece>. No matter how you find us, online or in the flesh, you are always welcome here.

Alumni Updates and Social Media

Our alumni are just as important to us as our current students and faculty. While we helped prepare you for your accomplishments, we may not have heard about the results of your hard work.

Please share them with us!

If you've won an award, want to share industry news or a job opening, or have any

other information of interest, send it our way.

Want to become more involved through a gift of your time, talent, or treasure?

We would be delighted to know that, too.

Please drop us a line at eceinfo@mtu.edu, or visit our website at www.mtu.edu/ece to learn how you can continue your relationship with the ECE department.

You can also stay local and be social by liking us on Facebook (www.facebook.com/ECEDeptMTU) and following us on Twitter (twitter.com/mtuECE) for department news, awards, staff updates, and student stories.

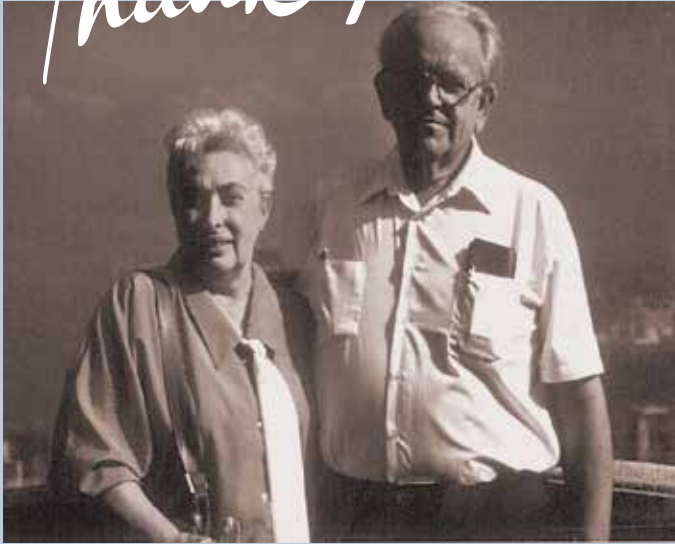
On the Cover

Michigan Tech's annual Career Fairs show ECE students are in demand.

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

Thank You



Earl R. and Ellanette F. Lind

Memorial Endowed Fellowship

Thanks to a generous gift from the estate of Earl '50 and Ellanette Lind, an endowment fund has been established to provide annual fellowships for Michigan Tech graduate students in electrical engineering.

The planned gift of \$645,000 was realized in March 2014. The Earl R. and Ellanette F. Lind Memorial Endowed Fellowship will provide financial support for a graduate research assistant under the direction of their research active advisor in the area of electrical engineering.

Earl Lind was born in Duluth, Minnesota in 1927. After graduating from Sault Ste. Marie High School, he earned a BS and MS in electrical engineering at Michigan Tech.

Lind served in the United States Air Force and then went on to earn his PhD in electrical engineering from University of Wisconsin-Madison.

His career brought him to Raytheon where his work earned several patents, including one for sonar technology, before he retired as vice president and chief engineer.

In 1966 he married Ellanette F. Jurd. Ellanette also served in the US Navy Reserve from 1944 to 1966 in aircraft and flight instrument maintenance. She continued to be of service to others including more than 1,000 hours volunteered for her local hospital.

She passed away in October 2013 and Earl less than two months later in December. The couple was married for 47 years.

Graduate support from philanthropic gifts such as the Lind Fellowship are extremely valuable in helping the ECE department meet its strategic goals in research and faculty development, according to ECE chair Dan Fuhrmann.

"We use these fellowships primarily to support students working with newer faculty members whose research programs are just getting off the ground, and may not yet have a solid base of external funding," he says. "Obviously the Linds had strong ties to Michigan Tech and we are extremely grateful that they remembered us in their planned giving."

Major Gift Acknowledgements:

The House Family Foundation has made a gift of \$671,000 to the Institute of Computing and Cybersystems. These funds will be used to support post-doctoral research associates and visiting professors over a period of two years, as a means of catalyzing and energizing the research activity of ICC faculty during its critical initial launch period.

David Brule Sr. '72, president and owner of Systems Control, Inc., of Iron Mountain, Michigan, and a member of the ECE Academy, has made a gift of \$250,000 for scholarship support in the ECE department over the next five years. The intent of the scholarship is to promote study in electrical power transmission and distribution, where significant workforce needs are anticipated. Scholarship recipients will be known as Systems Control Scholars.

Jim '61 and Marlene Fugere of Boulder, Colorado, have made a significant gift of stock to Michigan Tech. Funds will be used for program support in computer engineering. Jim is a long-time supporter of the ECE department; his previous gifts were instrumental in the renovation of the 5th floor of the EERC.

Paul Williams '61 of Torrance, California, also an ECE Academy member, has made a gift of \$40,000 to the ECE department in 2016. Over the past five years Paul has given \$500,000 to the ECE department to support infrastructure and research activity in the Center for Computer Systems Research, and for undergraduate scholarship support.

Catching up with Professor John Lukowski



Associate Professor John Lukowski is involved in every aspect of the ECE's undergraduate programs, and then some. He is chair of the Undergraduate Programs Committee, ABET coordinator, Senior Design instructor, and Hybrid Electric Vehicle (HEV) Enterprise co-advisor, member of the ECE Executive and Lab and Space Committees, and, last but definitely not least, instructor for over 27 different undergraduate courses during his tenure. We recently had a chance to chat with John about his experiences.

Q. What do you enjoy most about teaching at Michigan Tech?

A. This is my 32nd year teaching at Tech, and I can tell you, with 100 percent confidence, that if you ever want to know if you truly understand something, try teaching that something to someone else. The vast individual differences in thinking and approaches to solving complex problems forces an instructor to look at a body of knowledge from many different angles; only after can they formulate a way of conveying that knowledge in a fashion that the majority of students can comprehend. If you repeat this process for every topic that is contained in the 27 different courses I've taught during my tenure here, you'll see that there has been plenty of thought, analysis, and planning done on a daily basis. The most gratifying aspect of teaching happens several years after graduation, when I'm visiting a plant, business, or lab and a former student recognizes me, smiles proudly as they walk over to shake my hand, and begins to talk with great excitement and authority on the project, process, or technology they're working on. That's when I know that I've done my job. It's not that I was successful in conveying a bunch of eons-old theories and laws, but I was able to help an individual master the fundamentals, and gave them the confidence to apply them in the creation of new knowledge. "Teach a man to fish..." , yep, that's what it's all about.

Q. You're co-advisor of the Hybrid Electric Vehicle Enterprise. Can you tell us about the projects you and your students are working on currently?

A. The goals and efforts of the HEV Enterprise have undergone several revisions in the recent past. Currently we are 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. It's extremely complex and very, very cool!

Q. As ABET Coordinator can you tell us what's involved in keeping the ECE program accredited?

A. The key to any successful accreditation program is cooperation. As the ECE ABET coordinator, I need semester-by-semester data from the faculty delivering our undergraduate courses to monitor our curriculum. It is only with a steady stream of valid data that we can identify and address areas of concern and institute change to improve the programs within ECE. A good assessment program does lead to incremental improvement in the quality of our programs.

Q. You work a lot with the Senior Design teams. What insights can you share about the next generation of engineers and innovators coming out of ECE?

A. Richard Henry Dann once said "He who dares to teach must never cease to learn." This is what project work means to me. Working with teams of soon-to-be engineers and going through the process of navigating the investigation of an open-ended problem always offers learning opportunities. The technologies employed by electrical engineers and computer engineers are evolving at an ever-increasing rate. Aside from the fundamentals, what you learn in your coursework today will most likely be obsolete tomorrow. When a student graduates, their formal education comes to a close; their life of learning however has just begun. The sooner I get students to understand this, the sooner they can transition to the notion and necessity of lifelong learning.

Q. As undergraduate programs committee chair, what is the most valuable advice you would give to a new ECE student?

A. You are the biggest part in the equation to your success at Michigan Tech. What you put into your education is what you will reap upon graduation.

Q. You seem to be well occupied at work, do you get any down time?

A. I'm glad you asked that question. As a hardcore Type-A personality, one has to be careful not to let one's work become all-consuming. But, yes, I do have a life outside of 1400 Townsend Drive; it's played out on a small farm in rural Hancock. My wife Terrie and I have raised mainly beef cattle and breeding sows over the years, but a mule, donkeys, chickens, ducks, geese and guinea and pea fowl have also called our place home. Of course the three dogs, Charlie, Sophie, and Casey, that serve as our substitute children, cannot go without mention.

Q. Is there anything else you want people to know about the work you're doing at Tech?

A. I'm an experienced Great Lakes mariner and have shared my knowledge by teaching boating and seamanship classes through the United States Coast Guard Auxiliary in Dollar Bay. MTU's Great Lakes Research Center (GLRC) has also tapped that skill set, helping out on the research vessel *Agassiz* when they were short-handed. My background and interest in metallurgy is evident from my long-term collaboration with the Department of Materials Science and Engineering. I've taught courses in instrumentation and electronic materials but my real expertise is in the area of Auger Electron Spectroscopy. I have built and implemented many custom modifications to MSE's Model 660 scanning Auger microprobe to facilitate unique and exciting experiments.

All-in-all it's been a pretty good run and hopefully they'll let me continue doing what I think I do best for another 10 years or so. Of course none of this would have been possible without the outstanding individuals who have trained, mentored, inspired, celebrated, counseled, and consoled me. We would need another volume of *The Circuit* to put all those names in print. Fortunately they know who they are and to whom again I offer my humble thanks.

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. Dr. Bos 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* and *Optical Engineering*.

Aurenice Oliveira, PhD



Aurenice Oliveira joins the Department of Electrical and Computer Engineering as an associate professor. Dr. Oliveira 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, Dr. Oliveira taught in the Electrical and Computer Engineering department 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*, *Optics Letters*, among others. She is a senior member of the Institute of Electrical and Electronics Engineers (IEEE), member of the American Society for Engineering Education (ASEE), and 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 News

Promotion and Tenure

Zhuo Feng was promoted from assistant professor to associate professor with tenure. The ECE department congratulates Prof. Feng on this accomplishment, and on all his achievements in research.

Awards

Glen Archer received 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 selected to the Dean's Teaching Showcase for AY2014-2015.

Durdu Guney was awarded Recognized Reviewer status by Photonics and Nanostructures—Fundamentals and Applications.

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

Shiyan Hu was named ACM Distinguished Speaker and IEEE Computer Society Distinguished Visitor.

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

Joshua Pearce received the Silver Quill Award from Brigadier General Anthony Funkhouser, commander of the Northwestern Division of the U.S. Army Corps of Engineers.

Zhaohui Wang received the Outstanding Service Award at the 10th ACM International Conference on Underwater Networks and Systems (WUWNet 2015). She was also selected as Outstanding Reviewer of the 2015 *IEEE Journal of Oceanic Engineering*.

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 Office of the Vice President for Research at Michigan Tech for the 2015–2016 and 2016–2017 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 to a two-year term starting January 1, 2015.

Jeremy Bos formed a new session "Optical Detection and Analysis for Space Situational Awareness (SSA)" at the 2015 IEEE Aerospace conference in March. He was also appointed to the SPIE Scholarship committee for a third year.

Lucia Gauchia serves as Associate Editor for *IEEE Transactions on Transportation Electrification*.

Durdu Guney serves on the editorial board of *Nanomaterials and Nanotechnology* as Associate Editor for *Nanodevices*.

Tim Havens served as an Associate Editor of the *IEEE Transactions on Fuzzy Systems*, was the Area Chair for Fuzzy Clustering and Pattern Recognition at FUZZ-IEEE 2015, served on the Program Committee for Recent Advances on Computational Intelligence in Defense and Security (Spring, 2016), and was on the Technical Program Committee for ISSNIP 2015. He also received the Eta-Kappa-Nu Professor of the Year award.

Shiyan Hu serves as an associate editor for *IEEE Transactions on CAD*, *IEEE Transactions on Industrial Informatics*, and *IEEE Transactions on Circuits and Systems*. He is also a guest editor for seven IEEE/ACM publications including *IEEE Transactions on Computers*, *IEEE Transactions on CAD*, *IEEE Transactions on Big Data*, *IEEE Transactions on Multi-Scale Computing Systems*, and *ACM Transactions on Cyber-Physical Systems*.

Saeid Nooshabadi was invited by the Dean of Graduate Studies and Research, University of Saskatchewan, Canada, to serve as external expert on the Graduate Program Review Panel for Electrical and Computer Engineering. The Panel met in Saskatoon in April 2016.

Aurenice Oliveira was appointed to serve as an ABET EAC evaluator.

Joshua Pearce serves on the editorial board of the journal *Sustainable Energy Technologies and Assessments* and he served as the guest editor for a special issue on solar photovoltaic materials for the journal *Materials*. He also serves on the board of directors of Open Source Ecology and the board of Libre 3D.

Syed (Reza) Zekavat was the organizer and chair of the Space Solar Power Workshop, and served on the steering committee for the 2015 IEEE WISEE conference in December. He was also the organizer and chair of the Space Solar Power Track at the 2015 IEEE RAST conference in June.



Institute of Computing & Cybersystems

Last May, Michigan Technological University's Alliance for Computing, Information and Automation (ACIA), established the Institute of Computing and Cybersystems (ICC). The ACIA seeks to provide faculty and students the opportunity to work across organizational boundaries to create an environment that is a reflection of contemporary technological innovation. As the research branch of the ACIA, the ICC carries out that mission by promoting research and learning experiences in the areas of cyber-physical systems, cybersecurity, data sciences, human-centered computing, and scalable architectures in an arena that is largely collaborative.

The institute has a diverse membership of 40 dedicated faculty members for 11 different schools and departments who function within five specialized centers (see page 7 for more details). Their expertise and willingness to work across traditional boundaries is paying off—\$2.9 million in research funding to date.

Jim Friendewey, ACIA Executive Chair explained another benefit of interdisciplinary research collaborations, “The structure of the ICC provides a means to leverage the diverse research capabilities of individual faculty members and researchers in order to develop larger, interdisciplinary projects.”

An example is the collaboration between Timothy Havens, ICC director of the Center for Data Sciences and Philart Jeon, ICC director of the Center for Human-Centered Computing, who were recently awarded a grant from the US Department of Transportation for the NURail Center, the first USDOT OST-R University

Transportation Center dedicated to the advancement of North American rail transportation, along with three other distinguished researchers.

Min Song, ICC Founding Director, also commented on the unique nature of the ICC, “We are striving to create an atmosphere of innovation and excitement surrounding computing and cybersystems. Multidisciplinary collaboration is at the heart of our efforts.” Song knows multidisciplinary collaboration well, having worked at the boundary of electrical engineering and computer science for much of his career. He currently holds joint appointments in CS and ECE.

Daniel Fuhrmann, chair of ECE, and ICC co-director, notes the important role of interdisciplinary work.

“We stand at the dawn of the era of the ‘Internet of Everything’, where computers, sensors and networks play an ever-increasing role in all aspects of our lives,” he says. “In order for Michigan Tech to remain a national leader as a technological university, it is critical that we have robust, visible programs in computer science and computer engineering and all engineering fields that are touched by computing. I am delighted that we have Min Song here to lead that effort and that he has pulled together the people to create this organization on campus.”

Michigan Tech Alumni and philanthropist, Dave House, has been supportive of the ICC's mission and is confident of its success. He showed his support with a generous donation from The House Family Foundation in late December. This gift will help to support the salaries of visiting faculty and a post-doctoral research fellow.

The ICC is striving to—

Think big—focusing on multifaceted and interdisciplinary projects that address regional and national priorities.

Think together—concentrating on harnessing the power of our fellow members, as well as our national and international academic colleagues and industry partners to discover, explore, and execute new ideas and technologies.

Computing & Cybersystems

The ICC has also strengthened relationships with funding agencies, industry, alumni, and donors through its Distinguished Lecturer Series that brings the most eminent scholars and creative professionals in the fields of computing and cybersystems to the campus to exchange state-of-the-art research results and discuss future research directions.

As the ICC approaches its first anniversary, leaders and members are gearing up for another successful year of research.

“In today’s world the lines between the traditional academic areas have disappeared. Engineers code, programmers design semiconductors, and the technologies they use have merged. The Institute of Computing and Cybersystems provides a platform for collaboration that brings these disciplines together to address tomorrow’s opportunities in the classroom, the lab, and the workplace.”

Dave House
House Family Foundation

5 Centers of Focused Research Activity



Center for Cyber-Physical Systems (CPS) CPS focuses on research and development in cyberphysical systems, the internet-of-things, smart homes, buildings, communities and grids, smart transportation, smart health, and underwater communications and networks.
Center Director: Shiyun Hu / shiyun@mtu.edu / <http://icc.mtu.edu/cps>



Center for Cybersecurity (CyberS) CyberS focuses on research and development in cybersecurity, information security and biometrics, privacy protection, trusted software engineering, and security in mobile computing, and wireless communications.
Center Director: Spiros Bakiras; sbakiras@mtu.edu; <http://icc.mtu.edu/cyberS>



Center for Data Sciences (DataS) DataS focuses on the research of data sciences education, algorithms, mathematics, and applications. DataS fosters interdisciplinary collaborations by bringing together diverse faculty and students from varied disciplines to discover new knowledge and exciting research opportunities in the field of data sciences.
Center Director: Timothy Havens; thavens@mtu.edu; <http://icc.mtu.edu/datas>



Center for Human-Centered Computing (HCC) HCC focuses on research development of multimodal interactions, human-agent interactions, assistive technologies and intelligent health, software education, novel interfaces, and computational modeling.
Center Director: Myounghoon (Philart) Jeon; mjeon@mtu.edu; <http://icc.mtu.edu/hcc>

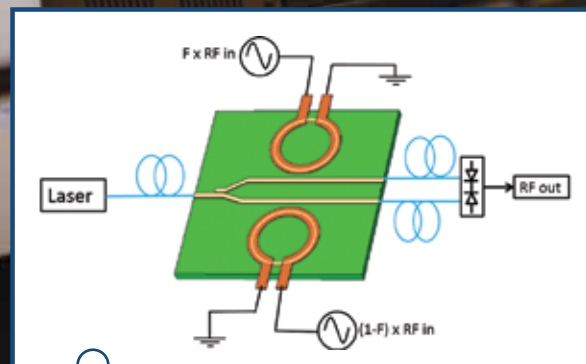


Center for Scalable Architectures and Systems (SAS) SAS focuses on research and development in scalable computer architectures and systems, heterogeneous parallel and distributed computing, embedded systems, dependable computing, formal methods, fault tolerant systems, VLSI design and CAD, architectures for secure systems, virtualization, and scalable algorithms. Center Director: Saeid Nooshabadi; saeid@mtu.edu; <http://icc.mtu.edu/sas>

To learn more about the ICC, visit <http://icc.mtu.edu/> or email icc-contact@mtu.edu.



Christopher Middlebrook



THE OPTICAL CONNECTION

Imagine you are at the local coffee shop enjoying your favorite mocha latte and zipping along on the complimentary Wi-Fi when rush hour hits, filling the seats and slowing your connection to the Internet to a decaffeinated crawl.

This scenario might be a slight annoyance, but the need to reduce bottlenecks for high-speed wireless computing and networking applications becomes much more critical when it involves business operations, air traffic control, military communications, and security. The need to communicate and retrieve data with ever-increasing speed, combined with larger numbers of users simultaneously accessing networks, requires greater network capacity.

One key to increasing network capacity is the expanded use of optical communication links, in which the data is transmitted using pulses of light through glass fiber instead of electromagnetic waves traveling along wires or through free space. Implementation requires high performance devices that operate at the boundary of these two worlds, modulating optical signals in reference to electrical signals. This is the domain of microwave photonics, one of the research areas of ECE Associate Professor Christopher Middlebrook.

Prof. Middlebrook and his research group have designed a novel integrated electro-optic modulator for microwave photonic applications. This novel modulator design exceeds performance requirements for microwave photonic link applications at bandwidths of 40 GHz. The new device is designed to be a drop-in replacement for existing applications.

This electro-optic modulator design is being further developed with the support of a recent \$346,268 contract from the United States Defense Advanced Research Projects Agency (DARPA). Fabrication of the structure is being completed within the Micro-Fabrication Facility (MFF) at Michigan Tech and testing will be conducted in Prof. Middlebrook's microwave photonics laboratory. Utilizing the power of *Superior*, Michigan Tech's own supercomputer, Middlebrook is simulating complete device characteristics that have verified theoretical predictions for the prototype modulator.

Two patents on the modulator designs have been submitted to United States and international patent offices. Middlebrook is pursuing full commercialization of the device, as well as a broadening of the concept for deployment in multiple customer markets.



Lucia Gauchia

Extending battery life

As the use of batteries in a multitude of applications continues to expand, affordability and determining the effects of aging remain critical challenges.

These issues drive the research of Lucia Gauchia, the Richard and Elizabeth Henes Assistant Professor of Energy Storage Systems who holds a joint appointment in ECE and Mechanical Engineering-Engineering Mechanics. She is also the director of the Energy Storage Systems and Sustainability (E3S) Lab at Michigan Tech.

Gauchia's research interests are focused on the testing, modeling, and management of energy storage systems in both transport and stationary applications.

In the E3S Lab, teams of researchers are working on estimating methods to understand the relation between battery aging and these services, and how they need to be aggregated to consider battery degradation among populations on batteries deployed by utilities.

"Batteries, when connected for example with photovoltaic panels, can provide different services: re-charge during sun hours to discharge at night, provide energy during a power outage, shave power peaks due to load requirement and also provide services back to the grid," Gauchia says. "However, they have a limited lifetime, and each service cycles the battery in a specific way that determines its aging.

"It is largely unknown how the combinations of those cycles actually affect the battery aging, and how each should be paid considering the service they provide and the aging cost they assume with each," she says. "At the lab we are working on estimating methods on understanding the relation between battery aging and these services, and how they need to be

aggregated to consider battery degradation among populations on batteries deployed by utilities."

The E3S lab is engaged in a variety of projects, often working across disciplines and with researchers from across campus.

Activities at the Lab include:

- Testing electrochemical storage systems such as batteries and ultracapacitors
- Modeling storage systems for vehicle and grid applications
- Estimation of cycle aging depending on service requirements
- Design of mechanical storage options for wave energy converters

One project in the lab includes studying traffic flow theory impact on electric vehicle battery performance. This study focuses on testing batteries under real-driving cycles, and includes Kuilin Zhang, Civil and Environmental Engineering, and Jeffrey Naber, Mechanical Engineering-Engineering Mechanics.

Additional projects in the E3S lab include holistic energy storage selection, a household independent power project, adaptive battery systems for hybrid applications, and hybrid PV-storage generation for a portable 3D printer.

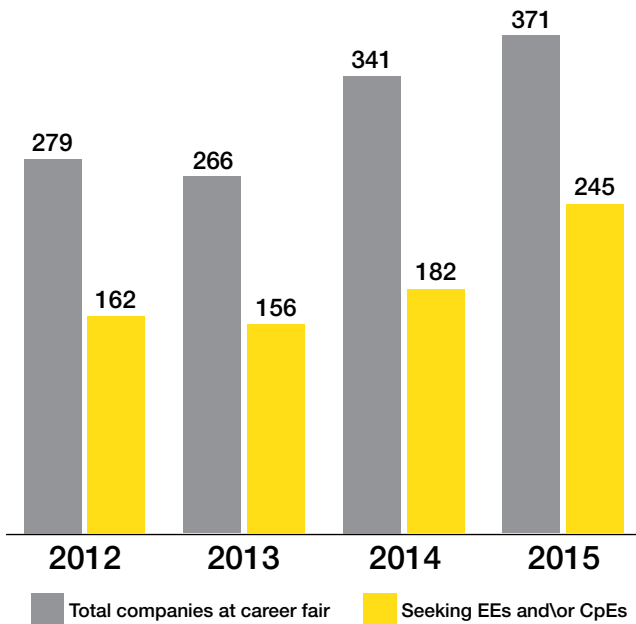
Gauchia received her PhD degree in Electrical Engineering in December 2009 from the University Carlos III of Madrid (Spain). She was a Postdoctoral Research Associate during 2012 at McMaster University (Canada), working for the Canada Excellence Research Chair in Hybrid Powertrain in ECE as well as in the Green Auto Powertrains Program in ME-EM.

ECE Graduates are in Demand

This past September, Michigan Tech held its Fall 2015 Career Fair at the Student Development Complex. 371 recruiting organizations were on campus and fully 2/3 of those companies were looking to hire electrical and/or computer engineers, among others, for full-time, co-op, and internship positions. With starting salaries said to be pushing \$70,000 and higher, and a placement rate of over 94 percent, we are hearing the message loud and clear—ECE graduates are in demand!



Career Services Director Steve Patchin said, “In speaking with 371 recruiting organizations at Michigan Tech’s Fall Career Fair, largest ever in our history, we found an ongoing theme, electrical engineers. Companies I spoke with personally included Systems Control, Nexteer, Ford, Bosch, Fast Enterprises, Shipston Aluminum Technologies, Halla Mechatronics, Powertech Services, and Gerdau, just to name a few. This diverse group of recruiters had one thing in common, a thirst for EEs and CpEs that was insatiable.”



According to recruiters, the hottest area for EEs right now, as it has been for several years, is controls. Control (in the engineering sense) is all about making engineered systems do what you want them to do, from cars to motors to appliances, to large factories and steel mills. The push toward automation in all areas of our society and economy is driving a demand for engineers who understand this field. Controls engineers tend to have broad interests, since to be successful one must have mastery over the mathematical fundamentals, as well as a working knowledge of the systems and components being controlled, which could be electrical, mechanical, or chemical. This combination of theoretical and practical skills seems to

match our students quite well. The ECE department is working on several fronts to strengthen its course offerings and create more design project opportunities in this critical area.

For the first time, Michigan Tech made the fall and spring Career Fairs the centerpiece for dozens of events throughout the school year, collectively known as CareerFEST. The inaugural CareerFEST kicked off in early September with a series of Industry Days, each featuring a specific industry sector. Special events included Foundry Day, Automotive Day, Energy Day, Steel Day, Railroad Day, and more. Representatives from companies met with students in relaxed, informal outdoor settings, and discussed challenges and opportunities in their fields, and in some cases there were additional entertaining and educational activities. The events continue this spring with Information Technology Day, Consumer Products Day, and Medical Careers Week.

Patchin was pleased with the results of the CareerFEST events saying “Of those students attending one of the Industry Days, 65 percent discovered careers and/or industries that interested them that they did not previously know about. Additionally, 85 percent found it easier to network with industry representatives than at the Career Fair. Industry Days, as part of CareerFEST, allowing students to find their fit, helping them to chart their career path while adding relevance to their studies.”

The Career Fair and other CareerFEST events do more than just find jobs for our students. It also helps to strengthen our relationships with industry partners and keep us informed about what we need to be doing in our educational programs, both for them and for our students. What has emerged is a three-way “ecosystem” involving the University, the students, and industry, which right now seems to be working really well for everyone. The exciting challenge now is to keep those relationships thriving in an era of constant technological, economic, and societal change.

The founding legislation of Michigan Tech includes a clause that the University “shall seek to promote the welfare of industries in the state.” Michigan Tech Career Services, widely regarded as one of the best of its kind in the country, works very hard to do exactly that, in close cooperation with industry partners and academic departments. The ECE department acknowledges Career Services for the outstanding job they are doing on behalf of our students.

Student News

IEEE Student Branch



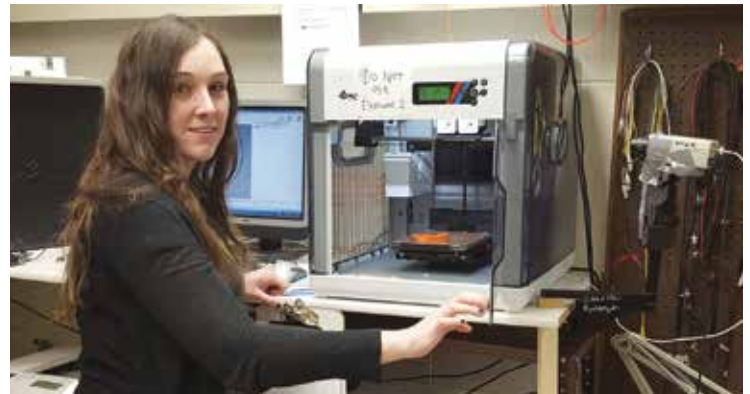
The Michigan Tech IEEE student branch has long been a staple for student involvement and professional development. The branch has recently undergone a major reorganization, including a new constitution, a new faculty advisor, an IEEE-compatible code of conduct, a more welcoming and inclusive working environment, and significant laboratory upgrades. The revitalized

branch now boasts a roster of 128 members from several departments and colleges.

The IEEE student branch hosts speakers, conducts seminars, and acts as a service organization for Michigan Tech and the community. But its primary function is to operate the IEEE laboratory in room 809 EERC, a student run work space (a.k.a. Hacker Space) aimed at tinkerers, builders, and would-be innovators. It is a fully equipped and stocked electronics lab with tools, bench equipment, software, and free supplies of common components. As such, it provides extracurricular opportunities for students to improve their design and building skills, and to turn their personal ideas into reality.

The IEEE lab has recently been remodeled and upgraded. New power lines have been installed, the electronic components inventory has been increased, and old bench equipment has been replaced. The members also selected and purchased the components for a new state-of-the-art disk server and three new workstations, then assembled and programmed a new network domain for the lab.

The mantra in the lab is: “it’s more fun to build than to buy.” Given a choice, members would rather assemble their own equipment than buy commercial off-the-shelf products. For example, they recently acquired a new 3D printer, but immediately modified the firmware to



their own needs. They used the 3D printer to fabricate replacement parts for the IEEE Hexcopter drone, damaged in a “hard landing” last year. Members now plan to program the drone for fully autonomous operation by summer. In order to simplify the creation of custom printed circuit boards, they have designed and are constructing their own board mill, using a combination of re-purposed and custom 3D printed parts.

The branch also provides technical assistance to several organizations on campus, including the Robotic Systems Enterprise, the Blue Marble Security Enterprise, the Husky Amateur Radio Club, and a course in which students must assemble their own 3D printers.

We believe enthusiastic and passionate people make the best engineers, and aim to attract that caliber of person to the lab by providing opportunities that would otherwise be out of reach to the average poor college student. The highlight of the year is always MasterpiECE Mania, an annual design competition open to all Michigan Tech students. In this competition students are challenged to design, build, and demonstrate a project of their own choosing. The presentations are judged by a panel of ECE faculty members, and the top three projects are awarded substantial cash prizes. In addition, the winning projects are used in public demonstrations at various events throughout the year. The 2016 competition took place March 17. The IEEE Student Branch is advised by ECE Prof. Roger Kieckhafer.



Faculty take back the Maxwell Cup

The annual ECE faculty vs. students hockey game was held on December 5, 2015 at the John MacInnes Student Ice Arena. Team captain, Jeff “Bad Dog” Burl lead his team to an overtime victory, 13–12, against the youthful student team. Scoring the overtime goal for the faculty was Guy “We Needed a Fast Guy” Hembroff. Jake Hardin was named MVP. The teams were cheered on by fans of all ages. Prizes were given away throughout the game, followed by a pizza party in the SDC’s Blue Line Room.

Robotic Systems Enterprise

This past fall the ECE department took over sponsorship of the Robotic Systems Enterprise (RSE). With the increased demand from company recruiters for electrical and computer engineers in the area of controls, the RSE fits well in the ECE program offerings.

The Robotic System 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.

This year the enterprise is working on four projects. The first is sponsored by the Great Lakes Research Center (GLRC) to develop a better power management system for GLRC's weather buoys. The newly designed system will utilize a relay board to shut off certain combinations of environmental data collecting sensors in order to prolong battery life.

The second project is a control-tethered, submersible robot. Future design plans entail working with the GLRC to autonomously collect soil samples of polluted bodies of fresh water.

Third is the Counter UAV, a safe, legal method of deterring drones that are invading people's privacy. The current system would



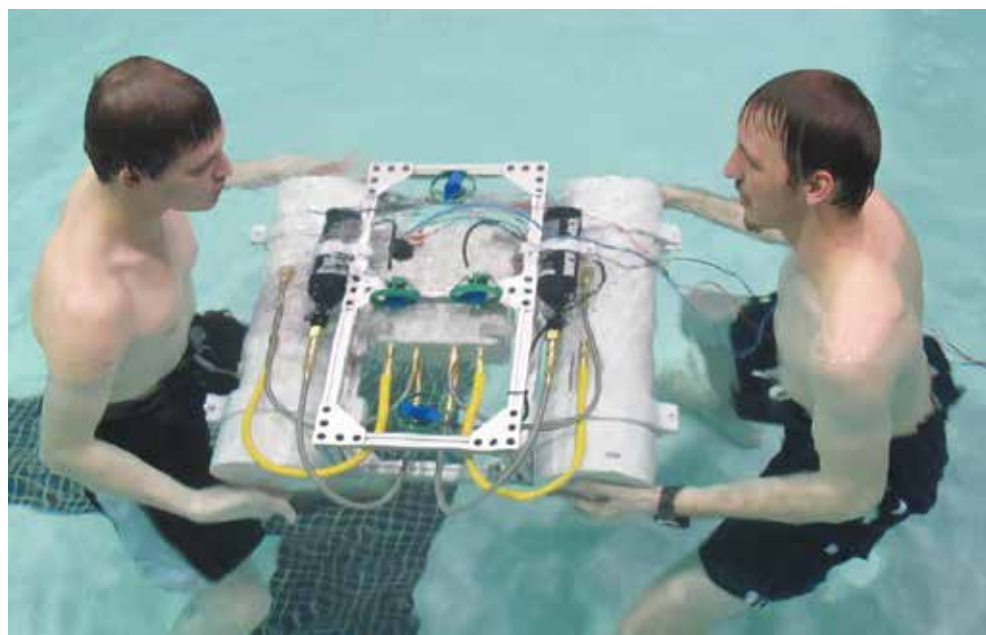
be mounted on a different drone that would be flown to intercept the invading drone by cooling the rogue drone's battery until the point where the invading drone must land due to not enough battery charge to operate.

The fourth project this year is an Exoskeleton, a knee joint of an exoskeleton system. The project inspiration was an assisting device for rehabilitation after knee surgery, arthritis, and other knee related health problems.

Currently the RSE team has 24 undergraduate students made up of Computer Engineering, Computer Network and System Administration, Computer Science, Electrical Engineering, and Mechanical Engineering majors.

The Robotic Systems lab is located in EERC SB23. With the change in sponsorship, the enterprise has had to start from scratch this year in terms of acquiring equipment and supplies needed for the projects and a dual extrusion 3D printer was purchased for modeling purposes. Computers are being upgraded to provide the team with software needed with plans to obtain more electrical equipment and components as funds become available.

The RSE is advised by Dr. Glen Archer.



2015 Student Awards

Undergraduate Student Awards:

ECE departmental Scholar: **Joshua Manela**

ECE Woman of Promise/Martha Sloan Scholarship: **Alexandra Roche, Andrea Henry**

Carl S. Schjonberg Award for Outstanding ECE Undergraduate Student: **Jordan Grider**

Larry Kennedy Industry Innovation Award

- Senior Design Team 5 for their project "Smart Bin for Real-Time Waste Monitoring in High Speed Manufacturing" sponsored by Kimberly-Clark. SD-5 team members: **Louis Bersine, Jake**

Fiebing, Yuancheng He, and Kaiquan Wang. Advisor: Don Moore

- Blue Marble Security Enterprise team titled "Outreach." BMS Outreach team members: **Gerri Chan, James Davis, Rebecca Gast, Andrea Henry, Tingzhao Huang, Zachary Pilarski, and Matthew Pollack. Advisor: Glen Archer**

Graduate Student Awards:

Jonathan Bara Award for Outstanding Graduate Teaching Assistant: **Bin Zhou**

Matt Wolfe Award for Outstanding Graduate Research Assistant: **Mehdi Sadatgol**



Chuck Sannes (left) and Mark Sloat support ECE's laboratories and assist students.

Full Spectrum Maintenance

Laboratories are the bridge between classroom instruction and real-world application, so keeping them in top working condition is a critical job.

Chuck Sannes, laboratory supervisor, and Mark Sloat, research associate, ensure the labs in ECE are always ready for faculty and students.

Sannes, '88, worked in industry for 15 years as an electrical engineer, and this is his second time working at Tech.

"I really like the variety," he says. "I enjoy working with students. During the year we set up the labs with equipment, fix things, make sure everything is calibrated accurately—I enjoy that. When people have questions, we always try to help out."

Sloat has been at Tech for seven years and has 12 years of industry experience. Working with students is also something he enjoys about the position.

"I like that it's more structured and scheduled," he says. "I enjoy the vast variety of projects we get to work on here. We're not doing the same things every day."

Both support ECE Senior Design projects and Enterprise programs as well as those from other departments.

"We help with technical questions," Sloat says. "A lot of students need assistance because they have the analysis and theory, but sometimes need help knowing where to begin."

They often assist others as well.

"We help a lot of departments across campus" Sannes says. "Forestry, ME-EM, the GLRC. I think we're kind of tied into everything on campus, so we help wherever we can."

Senior Design

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 in consultation with 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 are our Senior Design Teams for the 2015-16 academic year.

Project	Sponsor	Advisor
Railroad Car Wheel Contamination Detection	Norfolk Southern Railroad / MTU NURail Center	Duane Bucheger
dSpace Hardware in the Loop Development and Testing HiL, YR2	Nexteer Automotive	Jeff Burl
Utility UAV Specification Performance	ITC Holdings Corp.	Duane Bucheger
Utility UAV Inspection Interface	ITC Holdings Corp.	Trever Hassell
RAM Electrification and Idle Management	Fiat Chrysler Automobiles (FCA)	Duane Bucheger
Scaled Electrical Leak Location Solution	Electro Scan Inc.	Jeff Burl
Energy System Grounding	DTE Energy	John Lukowski
Traveling Wave Fault Locator	American Transmission Co.	John Lukowski

Details regarding our Senior Design and Enterprise programs are located on the ECE website at: www.mtu.edu/ece/undergraduate/capstone

Alumni Spotlight

Jeff Wells, '80



Jeff Wells graduated from Michigan Technological University in 1980 with a BS degree in electrical engineering

with an electric power option. He is a Licensed Professional Engineer in the state of Michigan.

After graduation, Jeff worked as a Plant Engineer for Goodyear Atomic Corporation located in Piketon, Ohio for three years. In 1983, he was hired by Consumers Energy (then known as Consumers Power) and has been there for over 32 years. Wells began his career with Consumers in Midland as a Plant Start-Up Engineer at the Midland Plant construction project.

He then moved to the Electric Substation Organization, first as a Field Engineer, then a Substation Supervisor and ultimately the Substation Maintenance Superintendent for the entire company. He has also held positions as a Region Electric Dispatch Supervisor as well as a Region Sales Director. Jeff spent 15 years in a leadership role for Distribution System Planning and Performance Team.

His present title is Principal Engineer – Lead heading up the Field Technical Support organization which is responsible for providing technical leadership, employee coaching and support and technical research and development supporting the management of over 1,150 substations in Consumers Energy's fleet.

During Jeff's 15 years as Manager of the Distribution System Planning and Performance Team for Consumers Energy, he was responsible for coordinating the recruiting and hiring of engineers associated with all aspects of the high and low voltage distribution segment of Consumers.

It was during this effort in the mid-1990s that he became re-acquainted with the ECE department. Jeff said he spent over 12 years on various campuses throughout the Midwest and it was then that he developed a strong understanding of the outstanding, and many times superior, quality of engineers who graduate from Michigan Tech. Jeff decided that if there was any way to support the program, he would provide his time and services.

In 2007, he was asked to substitute for Consumers Energy's sitting member of the

ECE's External Advisory Committee (EAC). "On this committee, I found a group of individuals dedicated to Michigan Tech, as well as a drive to insure the quality of an ECE/ Tech education remains as strong as ever and I knew I had found my niche," Wells explains. "In 2010 I was offered and jumped at the opportunity to become a member of the EAC and in the spring of 2015, I became the chair of this group."

"The EAC has provided me with an opportunity to give back to Michigan Tech by providing an avenue to offer industry insights I have developed in over 36 years as an electrical engineer"

Jeff lives in Mattawan, Michigan with his wife Laura. He has three grown children, Nicole Wells, Sarah (Wells) Peterson, and Adam Wells, and three grandsons. His daughter Sarah and son-in-law Davin Peterson are also Michigan Tech EE graduates.

He expresses his support for the future stating, "Michigan Tech is a recognized leader by industry of producing not only quality engineers, but also outstanding employees, and the EAC affords me the opportunity to insure this legacy continues."

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.

- Dave Aho, Eaton Cooper Power Systems
- Ellen M. Bauman, IBM
- Tony Champaign, Nexteer Automotive
- Rob Cooke, GS Engineering
- Jon Doane, MIT Lincoln Laboratory
- Ben Galloway, Dematic Corporation
- Brett Giem, Chrysler Corp.
- Gordie Halt, ITC Holdings Corp.
- Steve Kennell, Retired
- Brad Lebouef, Systems Control, A Division of North Star Industries, Inc.
- Bill Lepak, ArcelorMittal
- Eric Larson, 3M
- Ken Leisenring, Ford Motor Company
- Steve Mathe, Harris Corporation
- Dave Perry, Retired
- Matt Schroeder, General Motors
- Nirmal Singh, Detroit Edison
- Jeff Wells, Consumers Energy



Swenson Family Legacy

The name George Swenson is an important one in the history and legacy of the Department of Electrical and Computer Engineering at Michigan Tech.

George Swenson Sr., a native of Willmar, Minnesota, and a faculty member at the

University of Minnesota for 10 years, came to Michigan Tech in 1928 to become the founding chair of the new Department of Electrical Engineering.

His son, George Swenson Jr., grew up in Houghton and eventually earned his BSEE degree in 1944 from Michigan Tech. He went on to earn his MS from MIT and his PhD from the University of Wisconsin at Madison. He served on the faculties of Washington University, the University of Alaska, and Michigan State University, before accepting a position at the University of Illinois at Urbana Champaign in 1956. He is Professor Emeritus of electrical engineering and astronomy at the University of Illinois.

Swenson Jr. is most well-known for being the designer of the Very Large Array, or VLA, one of the world's premier astronomical radio observatories. The VLA consists of 27 radio antennas in a movable Y-shaped configuration on the Plains of San Agustin 50 miles west of Socorro, New Mexico. Each antenna is 25 meters (82 feet) in diameter, and the distance from one side of the array to the other, in the largest configuration, is 36km (22 miles). The data from the antennas is combined electronically to give very high-resolution images of the radio-frequency emissions of distant objects. See [http://www.newmexico.org/regions/southwest/large-](http://www.newmexico.org/regions/southwest/large-array-telescope/#.VvAFkU32aUk)



[array-telescope/#.VvAFkU32aUk](http://www.newmexico.org/regions/southwest/large-array-telescope/#.VvAFkU32aUk). The VLA is often depicted in popular culture, such as the science fiction movie *Contact* starring Jodie Foster.

Swenson Jr. is a Guggenheim Fellow and a member of the National Academy of Engineering and the Tech's Electrical Engineering Academy. In 1997 he was appointed adjunct professor of electrical engineering at Michigan Tech. He delivered keynote remarks at the most recent ECE Academy induction, in August 2014. The Swenson family has been a longtime supporter and donor to the electrical and computer engineering program at Michigan Tech.

The ECE department welcomed two new staff members in 2015.



Joan Becker began in April as ECE's Graduate Programs Coordinator. Joan is a Michigan Tech alumna receiving a BS in Business Administration in 1984 and has over 20 years of experience as a staff member within the University. Since joining, she has done a tremendous job assisting ECE graduate students, now over 250 MS and PhD, with various degree requirements and procedures from admission to degree completion and everything in between.

Kendrick completed his PhD in Electrical and Electronic Engineering at the University of Canterbury in New Zealand. He moved to the United States in 2008 to take up a postdoctoral position in the Department of Material Science and Engineering at Pennsylvania State University. His research at Penn State involved the growth and fabrication of silicon wire photovoltaic cells.

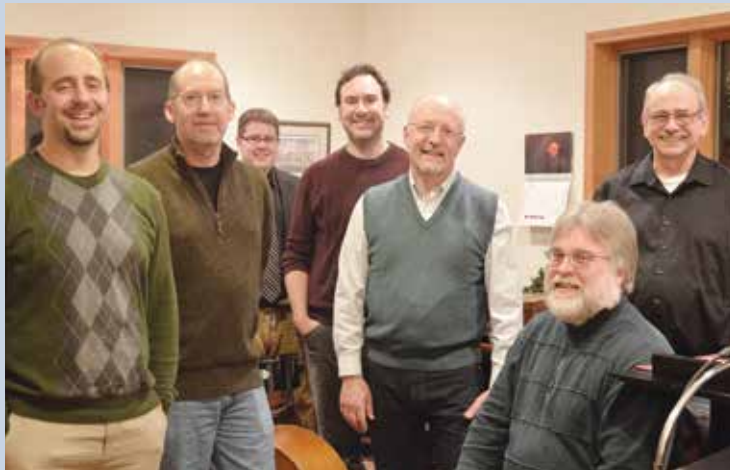
He then moved to the Colorado School of Mines as a research assistant professor in the Department of Physics, working on quantum-confined nanocrystalline silicon, a hybrid material that may allow for the fabrication of an all-silicon multiple junction photovoltaic cell or a photovoltaic cell that allows for hot carrier collection.

Kendrick relocated to Michigan Tech in 2014 with his wife, Yvette Dickinson, Assistant Professor of Forest Resources and Environmental Science. He took a part-time position as Research Assistant Professor with a joint appointment in the ECE department and the Department of Material Science and Engineering.



In May 2015, **Chito Kendrick** was selected as the new Microfabrication Facility (MFF) Managing Director after an extensive search. According to Prof. Paul Bergstrom, search committee chair, "Dr. Kendrick's strong qualifications and the depth and breadth of his experience in materials processing and device characterization at the micro and nano scale made him an ideal choice to move the Microfabrication Facility to the next level of capability."

End Note



from left to right: Kit Cischke, Tim Schulz, Kyle Frazier, Tim Havens, Dan Fuhrmann, Paul Bergstrom, and Roger Kieckhafer

It is said that Albert Einstein would use music to help solve complex problems. He also had a true passion for music and often played with an amateur trio on Wednesday nights at his home in Princeton. In 1929 Einstein was quoted in the *Saturday Evening Post* saying, "If I were not a physicist, I would probably be a musician." There might be something with that left brain, right brain theory.

Coincidentally, the ECE department also has its share of musicians and their talents range from vocals to violin, trombone, guitar, piano/ keyboards, saxophone, and drums.

Prof. Paul Bergstrom plays violin and trombone, and sings bass in the Michigan Tech Concert Choir. He has sung or performed with many choirs and chamber orchestras including the Concerto Grossi chamber orchestra at the University of Minnesota under the direction of Dr. Young Nam Kim.

Senior Lecturer Kit Cischke grew up playing a variety of saxophones (soprano, alto, tenor, and baritone) in his high school concert, jazz, and marching bands. He played soprano and tenor through his undergraduate days at Michigan Tech, including playing the Lieutenant Kijé Suite with the KSO and playing in the pit orchestra for *Guys and Dolls* during the Rozsa Center's opening season. Nowadays Kit sings, plays guitar and saxophone, and leads worship on occasion at the Bethany Baptist church in Dollar Bay.

Chair Dan Fuhrmann plays piano and keyboards in a variety of jazz and pop styles, and plays on occasion with several groups in the Houghton area, including Steve Jones and the Garden City Hot Club.

Prof. Tim Havens plays bass guitar and sings with local bands Realtime Jazz and Fat Cow which he started in 1996 as a student at Michigan Tech. All the Fat Cow band members now work at Michigan Tech and the group reunited when Tim joined the ECE faculty in 2012.

Prof. Roger Kieckhafer is a bass/baritone who has sung with the Pine Mountain Music Festival chorus and other local groups.

Prof. Tim Schulz did not play a musical instrument growing up but decided to try the acoustic guitar when he turned 50. Perhaps the correlation between math and music does exist as Tim now plays in a band called Uncle Floyd with Cam Williams (Finlandia University), Pete Moran (Materials Science and Engineering at Michigan Tech), and Pam Sheridan (from the Keweenaw Family Resource Center). Some ECE alumni may remember Cam from the days when he played in a local band called Peter Lorre.

Kyle Frazier, BSEE student, plays the drums in the Michigan Tech Jazz Lab band along with a small jazz combo called JazTec. He also joins in with Profs. Fuhrmann and Havens at times.

Whether music holds the key to help stimulate problem-solving ability or to unlock a life passion, you'll notice a common theme here in ECE.