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Department of Biomedical Engineering

Spring 2016

Spring 2016 Biomedical Engineering Newsletter

Department of Biomedical Engineering, Michigan Technological University


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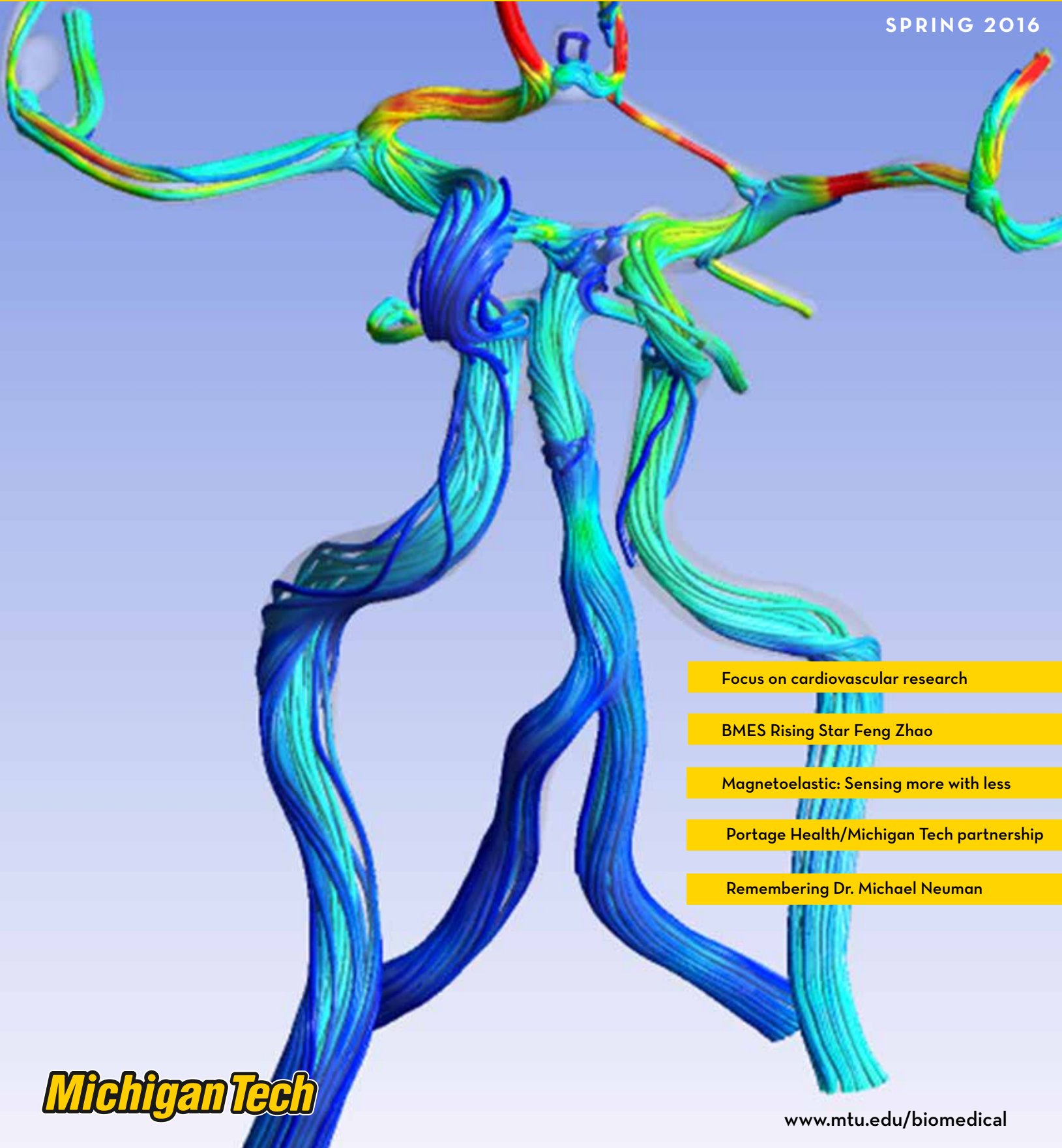
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MICHIGAN TECHNOLOGICAL UNIVERSITY

BIOMEDICAL ENGINEERING

SPRING 2016



Focus on cardiovascular research

BMES Rising Star Feng Zhao

Magnetoelastic: Sensing more with less

Portage Health/Michigan Tech partnership

Remembering Dr. Michael Neuman

Michigan Tech

www.mtu.edu/biomedical

LETTER FROM THE CHAIR



ON THE COVER: Jingfeng Jiang's image features streamlines of blood flow in a "patient-specific" brain phantom using 4-D phase-contrast Magnetic Resonance Angiography (MRA). Streamlines are color-coded with blood velocities. The anatomically-realistic brain phantom contains multiple vascular lesions including stenoses and aneurysms. This particular phantom (an apparatus that mimics the actual human anatomy for imaging testing) was used in collaboration with the Magnetic Resonance Group at University of Wisconsin-Madison.

Dear Friend,

THANK YOU for taking the time to read our Department of Biomedical Engineering newsletter. Opportunities for our students at all levels continue to grow, as do our research and teaching portfolios. It has been a fantastic year overall and I hope you enjoy reading about it.

Among our diverse research strengths is an emerging focus area in cardiovascular engineering. Many of our faculty members, graduate students, and undergraduate students are actively engaged in funded research aiming to improve cardiovascular function and diagnostics. Department research in cardiovascular engineering is wide-ranging and includes the development of a smart, bioabsorbable coronary stent, the design of novel metallic alloys for degradable stents, developing technologies for the treatment of heart failure and ventricular arrhythmias, non-invasive imaging of blood perfusion and tissue oxygenation, the engineering of completely biological cardiovascular tissues for regenerative medicine applications, and translational research into the physics of ultrasonic blood-flow imaging and analytics. Many of those research programs are highlighted inside.

The Portage Health Foundation has made a substantial contribution to Michigan Tech, which will not only benefit BME but all of the human health-related research and education that happens across campus. The donation will provide financial resources for undergraduate and graduate scholarships and fellowships, as well as provide funds for research and endowed professorships.

New faces have joined the BME community here at Michigan Tech. We are very happy to welcome four new people. Dr. Orhan Soykan, Professor of Practice, has long been associated with the Department, but now re-joins us in a more formal way, returning from Medtronic, Inc., where he was a Senior Principal Scientist and a Technical Fellow. He is a prolific inventor with a very productive career in medical instrumentation and devices. We are glad to have him back. Dr. Smitha Rao joined BME as an assistant professor last August. Prior to this she was a research assistant professor at the University of Texas at Arlington. Dr. Rao brings with her considerable expertise in microfabrication and biomedical instrumentation. Stacey Sedar and Cory Dompier are most welcome additions as our department coordinator and office assistant, respectively. Cory and Stacey have outstanding experience in office administration and we simply would not function without them.

Finally, we mark the passing of our friend and colleague, Dr. Michael Neuman. Mike had a long and outstanding career in the field of biomedical engineering and was one of the pioneers in applying rigorous engineering to solving human health-related problems. His knowledge, experience, and presence will be missed by all.

Sean J. Kirkpatrick
Professor and Chair

BIOMEDICAL ENGINEERING FACULTY

MEGAN C. FROST, PhD
University of Michigan
Nitric oxide-releasing polymers, implantable sensors

JEREMY GOLDMAN, PhD
Northwestern University
Lymphatic and blood vascular systems

JINGFENG JIANG, PhD
University of Kansas
Biomechanics and biomedical imaging

SEAN J. KIRKPATRICK, PhD
University of Miami
Biomedical optics, lasers, and imaging

BRUCE P. LEE, PhD
University of Wisconsin-Madison
Bioadhesives

KEAT GHEE ONG, PhD
University of Kentucky
Biosensors, passive implantable sensors

RUPAK RAJACHAR, PhD
University of Michigan
Biomineralization in vascular and bone-related cell types and tissues

SMITHA RAO, PhD
University of Texas at Arlington
Microelectromechanical systems (MEMS), nanotechnology

MARTYN SMITH, PhD
Yale University
Biostatistics

ORHAN SOYKAN, PhD
Case Western Reserve University
Implantable devices, biosensors, molecular medicine

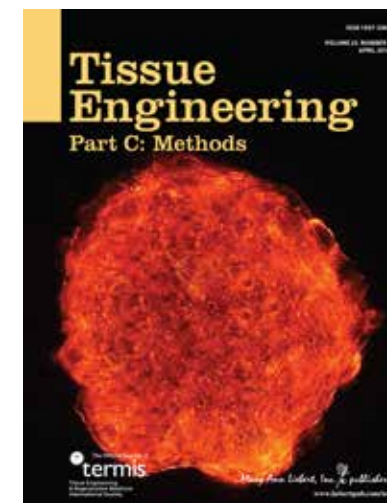
FENG ZHAO, PhD
Duke University
Tissue engineering

ABOUT THE DEPARTMENT

The Department of Biomedical Engineering at Michigan Tech is among the world's leaders in providing quality education and research. We have 11 faculty, several adjunct faculty, three staff members, 45 graduate students, and 300 undergraduate students. We are housed in the Minerals and Materials Engineering Building at the center of Michigan Tech's campus in Houghton. We offer programs leading to Bachelor of Science, Master of Science, and Doctor of Philosophy (PhD) degrees in Biomedical Engineering.

OUR MISSION

The Department of Biomedical Engineering serves the University, the community, and the biomedical engineering profession through education, research, and design activities. The department offers innovative educational programs that integrate biological sciences and engineering, and apply engineering tools, methods, and practices to solve problems in biology and medicine. Graduates of our programs are highly-skilled biomedical engineers who understand the ethical, social, and economic implications of their work.



A research image from Feng Zhao's article, "Physiologically Low Oxygen Enhances Biomolecule Production and Stemness of Mesenchymal Stem Cell Spheroids" appears on the April 2016 cover of *Tissue Engineering Part C*. Pictured is a fluorescent spheroid formed by approximately 4,000 stem cells. Reprinted with permission by TISSUE ENGINEERING, published by Mary Ann Liebert, Inc. New Rochelle, New York

REMEMBERING DR. MICHAEL R. NEUMAN



Professor Michael Neuman, physician, engineer, researcher and educator, passed away on February 17, 2016 from complications due to heart and kidney failure. He was 77.

Mike Neuman was born and raised in Milwaukee and went to Cleveland to study at Case Western Reserve University. He earned his undergraduate degree, as well as a PhD in electrical engineering in 1966 and an MD in 1974, all from Case.

In his 50-year academic career he initially taught at his alma mater before teaching at Duke, Memphis and finally at Michigan Tech, where he arrived in 2003 as Professor and Chair in the Department of Biomedical Engineering. He continued to teach after he stepped down as Chair in 2010.

Before going to medical school Neuman taught electronics in Case's electrical engineering department. He developed a strong interest in medical electronics, which was a new field at the time. He was intrigued by fetal monitoring, but knew nothing about obstetrics. "My colleagues encouraged me, and

asked me why I didn't go to medical school. So I did," he once recalled.

Neuman joined Michigan Tech at a point in his career when some faculty might be considering retirement. Instead he seized the oppor-

Mike will always be remembered as a devoted father and husband, a wonderful person with a subtle and ironic sense of humor, and a committed professor and scientist.

tunity to do more teaching, and to help young faculty develop their individual research programs.

"Mike has, and will always be, a transformative force in my life and my family, says Associate Professor Keat Ghee Ong. He brought me to Michigan Tech, essentially gave me my first 'real' job and helped me grow my career. I know he helped a lot of faculty members and their families the same way, too."

As an engineer, Neuman had a very strong background in physics and materials, as well as in electri-

cal circuits, and a vast knowledge of medicine, all of which allowed him to develop novel biomedical sensors constructed using micro-fabrication techniques and accessed by wireless technologies.

"Not only was Mike able to envision these concepts before anyone else, he was able to utilize the tools of the semiconductor industry that were available at the time to construct these devices," says Michigan Tech Professor of Practice Orhan Soykan. The two first met when he was Soykan's PhD advisor at Case. "Those of us who were fortunate enough to meet and work with Mike all know just how easy he was to be approached, how willing he was to help others and how he did his very best to mentor all his students, ranging from three-year-olds to graduate students, to new assistant professors."

Mike will always be remembered as a devoted father and husband, a wonderful person with a subtle and ironic sense of humor, and a committed professor and scientist. He is survived by his wife of 43 years, Judith Borton Neuman, his daughter Elizabeth Neuman (Joshua) Rose, grandchildren Emma Kathryn and Christopher Michael Rose, and a sister, Bonnie Neuman.

Anyone who wishes to remember Dr. Michael Neuman is invited to make a contribution either to the Cleveland Orchestra (www.clevelandorchestra.com) or to the Michigan Tech Department of Biomedical Engineering at www.mtu.edu/biomedical/department/giving/.

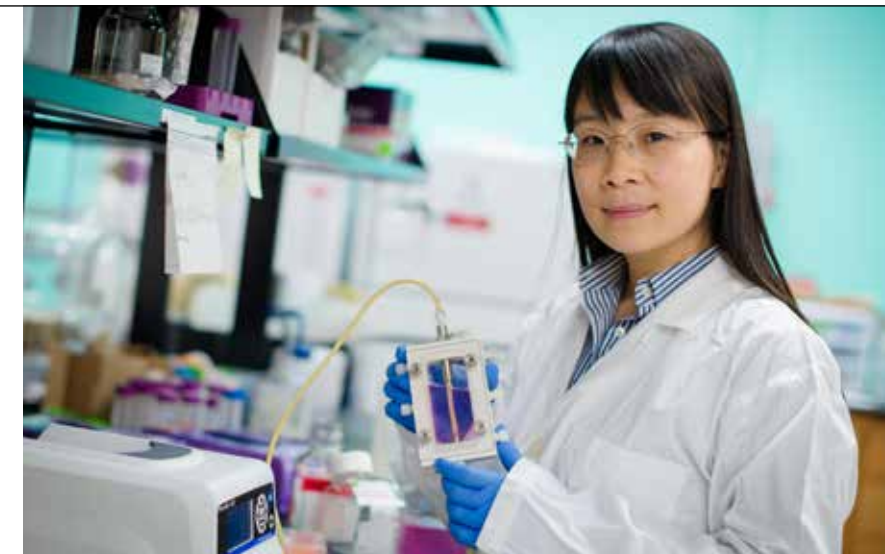
FENG ZHAO WINS RISING STAR AWARD FOR HER RESEARCH

In her regenerative heart tissue research, Feng Zhao makes nanoscaffolds from actual tissue. The Biomedical Engineering Society (BMES) has recognized Zhao, an assistant professor of biomedical engineering, with a Rising Star Award. She is one of six researchers in the nation to receive the honor.

"I am deeply honored and very excited to be recognized by peers in the cellular and molecular bioengineering field," Zhao says, adding that she appreciates the culture of her department and Michigan Tech. "My research fellows, students and I could not have produced a single piece of data without the strong support of this friendly and collaborative environment."

Zhao's research can be applied to multiple tissues including heart, blood vessels, nerve, skin, bone, skeletal muscle, and smooth muscles. Eventually, the tissues constructed in Zhao's lab could be used for grafts, implants and other medical procedures to help people recover from surgery or injuries.

Zhao builds 3-D tissues that are grown with a supply of capillaries—highly organized, prevascularized tissues. Her structures combine cells



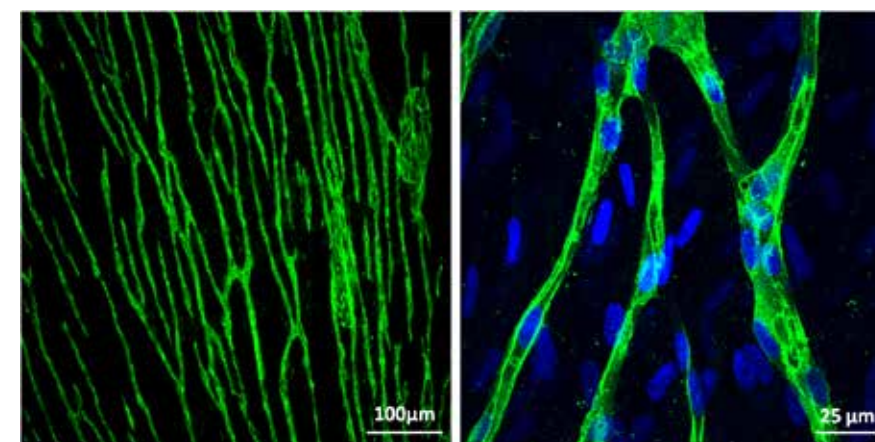
and fibers. "Prevascularization will solve the problems associated with many engineered tissues that don't get enough nutrients and oxygen, along with inadequate removal of wastes after implantation," Zhao explains. The core of her work focuses on creating naturally derived tissue nanofibers, made from fibroblast cells. Using natural nanofibers helps the body recognize it as real tissue, making it less likely to reject the material, which is a problem with current synthetic nanoscaffolds.

A bundle of one million nanofibers is about the same width as a single strand of human hair. On this tiny

scale, Zhao aligns all of the fibers, cells, and engineered capillaries, which are important for heart muscles because that alignment keeps a regular, steady rhythm.

Cardiovascular research is hard to do. Sean Kirkpatrick, the chair of the Department of Biomedical Engineering, says Feng's work shows how it can be done at Michigan Tech—and done well.

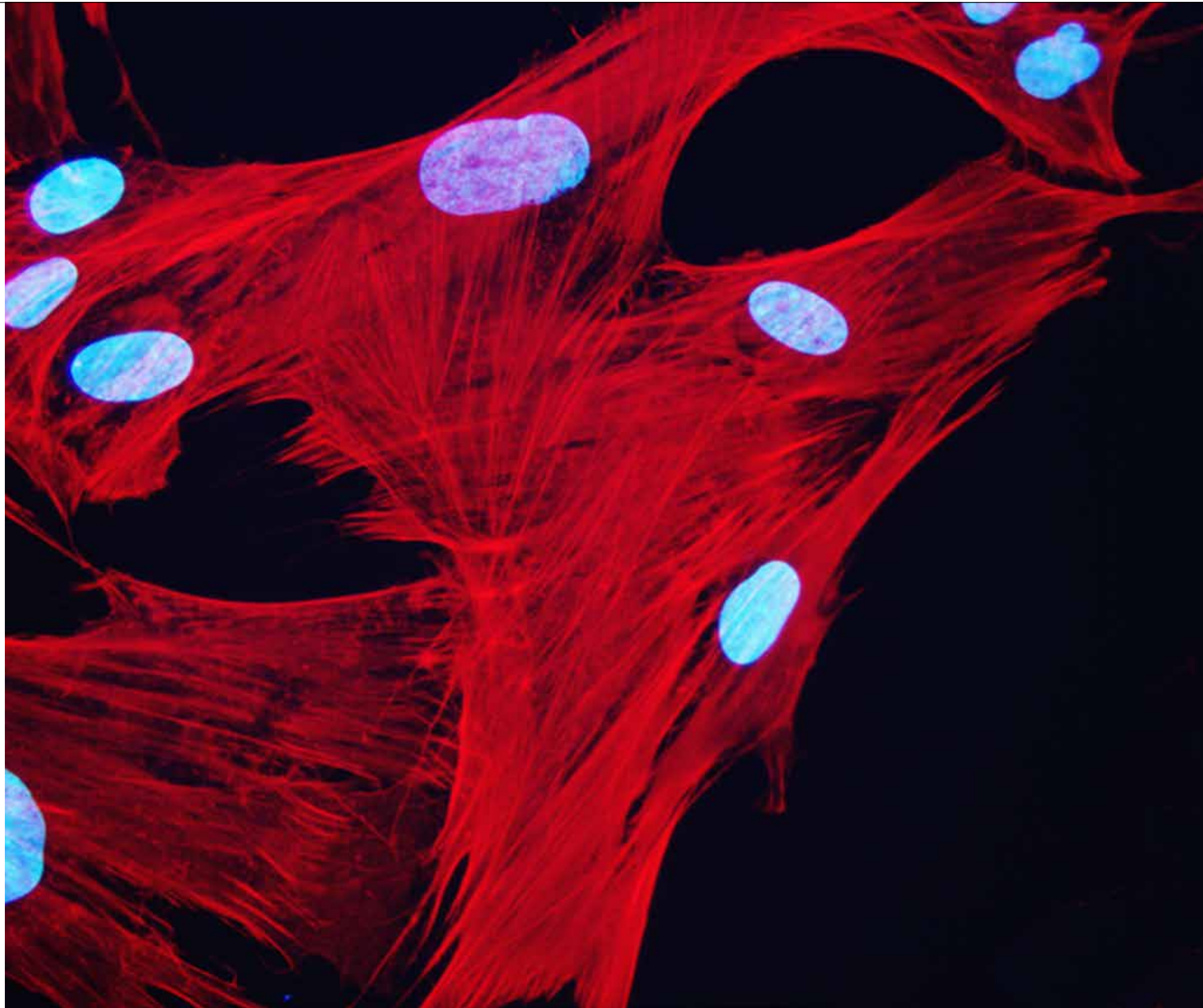
"We have a unique niche here on campus in biomedical engineering and applied physiology, where Michigan Tech can make a difference," Kirkpatrick says.



Engineered capillaries for providing nutrients and oxygen to cardiac tissues after implantation.

FENG ZHAO

CARDIOVASCULAR RESEARCH: FENG ZHAO



Human dermal fibroblasts, the cells that produce protein nanofibers in engineered tissues

FENG ZHAO

PARTNERING WITH PORTAGE HEALTH

A community health partnership between Portage Health Foundation and Michigan Tech will leverage the missions, strengths, and financial resources of both organizations to develop sustainable health, wellness, education, and economic growth.

The partnership, which serves four local Michigan counties, will collaborate with key community stakeholders such as UP Health System, the MTEC SmartZone, Health Occupations Students of America (HOSA) and the Great Lakes Family Health Center to provide health, wellness and educational resources.

The partners will each invest \$140,000 annually over the next five years to increase scholarships and health education opportunities for local students.

At Michigan Tech, the partnership will focus on research and education. Plans include:

- Three new endowed professorships at Michigan Tech to develop health-related community collaborations, increase health-related research, advance health technology, and foster innovative/entrepreneurial activity.
- Research Excellence Funds awarded annually to support high-potential, high-impact research projects in health. Funding will provide seed money for research projects, support for commercialization of health-related technologies, and funding for infrastructure and equipment.
- Portage Health Foundation scholarships/fellowships/internships/research experiences providing local undergraduate and graduate students the financial support and unique experiences they need to succeed in their health-related fields of study.

The partnership will increase human-health research not only in the Department of Biomedical Engineering, but across campus as well in programs such as Kinesiology and Integrated Physiology, Biology, Medical Informatics, and Chemistry.

Michigan Tech has more than 50 faculty working in health-related fields. The University's top capital outlay project request submitted to the State of Michigan for 2016 was a \$52 million health sciences and medical engineering building. And earlier this year, a Health Science, Technology, Engineering, and Mathematics Task Force was established to create a roadmap to reach Tech's long-term human health goals.



Graduate students Andrew DeRouin and Sterling Prince create a digital 3-D model to be used in the design of a smart knee implant.

EMILY SHEARIER: FOR THE LOVE OF RESEARCH



“I am amazed at the potential of stem cell research; that the stem cell applications I explored in my studies could help improve the lives of patients.”

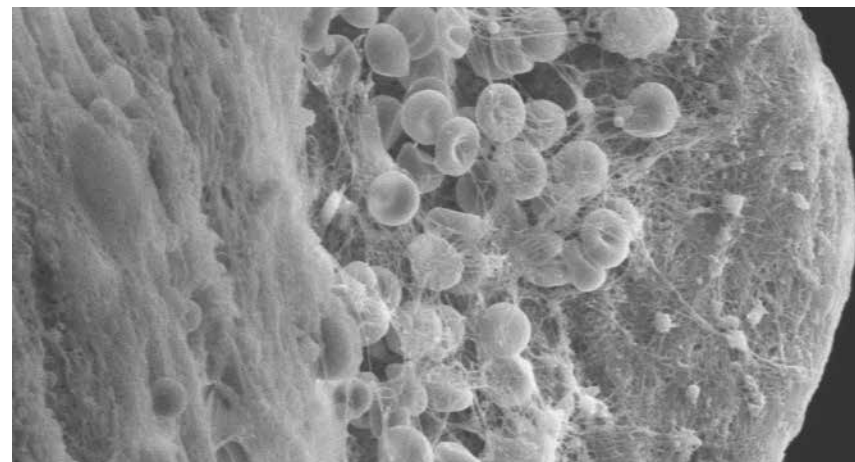
It was at the Mayo Clinic in Rochester, Minnesota that Emily Shearier fell in love with research. Initially on track for a medical career, the New London, Wisconsin, native took advantage of the Summer Undergraduate Research Fellowship program in her third year studying biology at Michigan Tech. For Shearier, the program helped her realize that the thrill of discovery and problem solving she was experiencing through research could become a lifelong passion and a career.

Drawn to applied research, she set forth on a new path and enrolled in a doctoral program in biomedical engineering. Shearier was drawn to her advisor, Feng Zhao, based on her research in adult stem cells. There are numerous applications for stem cells within the body, particularly mesenchymal stem cells, and the opportunity was exciting to Shearier. Once mesenchymal stem cells are taken from a patient’s bone marrow or fatty tissue they can be used to construct new cells for various parts of the body.

The manipulation of these stem cells offers enormous

potential in cancer research, heart disease mitigation, and neural regeneration. One specific application is with individuals who face circulation issues and a slower healing process due to diabetes. Through Shearier’s stem cell construct, a cluster of cells may be injected into diabetic wound sites to aid in the healing process.

The cells also have the potential to benefit patients with breast cancer who have had their lymph nodes removed. In many cases, removal can cause lymphedema, or swelling of the limbs due to the lack of lymph fluid released to the impacted



Morphology of proteins and red blood cells, from one of Shearier’s projects.

limb. It may be possible in the future for these constructed cells to be inserted to re-establish the flow of the lymph fluid. She realizes that while her research is years away from possible treatment in humans, the potential for impact is real.

“I am amazed at the potential of stem cell research; that the stem cell applications I explored in my studies could help improve the lives of patients,” she said.

Shearier defended her dissertation in November and walked in the December 2015 graduation ceremony. She recently accepted a position at UConn Health Center in Farmington, Connecticut as a post-doctoral fellow doing pediatric urology research. Her long-term goal? Shearier wants to lead a research laboratory.

KIMBERLY D’AUGUSTINO: A LEADER TO THE CORE



The prestigious Michigan Tech President’s Award for Leadership is given to one student each year. Kimberly D’Augustino, a double major in Materials Science and Engineering and Biomedical Engineering, was given the honor in 2015. D’Augustino excelled in academics while also taking full advantage of many opportunities—both on campus and off.

During her time as an undergraduate at Michigan Tech D’Augustino had internships with Nucor and Plexus; served as Vice President of the Biomedical Engineering Society; mentored students as a Success Coach and an ExSEL Mentor through the Waino Wahtera Center for Student Success; volunteered as an event coordinator for the American Cancer Society

Relay for Life; and worked for the University’s Center for Pre-College Outreach.

D’Augustino served as President of Mind Trekkers, a road show of Michigan Tech undergraduate and graduate students who bring the WOW! of science, technology, engineering, and math into the hands and minds of K-12 students across the country.

Soon after graduation, D’Augustino started work at Boston Scientific in Maple Grove, Minnesota as a manufacturing engineer supporting peripheral vascular interventions. She is still involved in STEM (science, technology, engineering, and math) outreach as an industry professional. She joined the STEM council at Boston Scientific and volunteers in the Twin Cities to

help under-represented minority students get exposure to STEM. She is working with the council to develop a global STEM platform across Boston Scientific. “I encouraged Boston Scientific to attend the 2016 USA Science & Engineering Festival in Washington DC for the first time last April,” says D’Augustino. “We met up with the Michigan Tech Mind Trekkers and other top industry representatives to benchmark and develop our own programs.”

3-D PRINTING DESIGNS

The plastic model in Kathleen Ikeda’s hand looks like a chubby bendy straw that had an unfortunate adventure in the oven. But it’s actually a 3-D printed version of an aneurysm bulge in an artery. The small pinched section in the middle is a device designed by a team of undergraduate biomedical engineering students.

“We’re evaluating this device that can bypass the clot,” says Kyle Johnston, who is one of the Senior Design team members. He explains the plastic model is the physical version of the design the team developed using virtual processing software. Basically, they were able to create a highly accurate and fine-tuned device using a computer program—and even tested their work virtually, saving tens of thousands of dollars



3-D printed model showing a flow-diverting device within a blood vessel. The device is designed to reduce flow into an intra-cranial aneurysm.

in equipment. The design was made for Materialise, which specializes in 3-D printing software and services.

“In a way, we’re like contractors,” Ikeda says. “We’re showing the

company how their software could be integrated into a new field—it demonstrates the versatility of their services.”

BME EARNS TOP HONORS AT DESIGN EXPO 2016

Over 50 engineering senior design teams competed recently at the Michigan Tech Design Expo (formerly the Undergraduate Expo). The Expo has been taking place for the past 16 years, and BME department teams consistently win top honors. Check out a historical list of all Expo award winners—including undergraduate research and Enterprise teams at www.expo.mtu.edu.



First Place

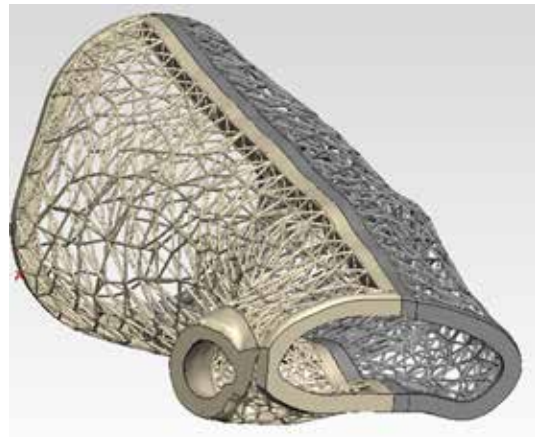
Epicardial Pacemaker Fixation

Team Members: Joe Nugent, Kate Boyles, Beth Sickles, and Dani Blake, Biomedical Engineering
Advisor: Rupak Rajachar, Biomedical Engineering
Sponsor: Medtronic

Second Place

Subject-specific Orthopedic Wrist Cast

Team Members: Tobias Mahan, Kathleen Moyryla, Konner Westerhouse, and Nathan Wilkinson, Biomedical Engineering
Advisor: Jingfeng Jiang, Biomedical Engineering
Sponsor: Materialise



Design Expo Past Honors

2013

Third Place

Attachment & Release Mechanism for Catheter Delivery Device

Team Members: Hal Holmes, Jon Juszkiewicz, Alex Keim, Michael Lancina, Uziel Mendez, Kyle Mentink, and Will Paces, Biomedical Engineering
Advisor: Rupak Rajachar
Sponsor: Medtronic

2012

First Place

Bioabsorbable Polymer-Coated Metal Stent Degradation Simulation Design

Team Members: Kristina Price, Brendan Daun, Thomas Faulkner, Erin Larson, Derek Yesmunt, and David Strobel, Biomedical Engineering; and Kelsey Waugh and Matt Gardeski, Materials Science and Engineering
Advisors: Dr. Jeremy Goldman and Dr. Jaroslaw Drelich
Sponsor: Boston Scientific

Third Place

Portage Health Noise Monitoring Device

Team Members: J. Ethan Lynch, Shaubhik Bhattacharjee, Trent Jansen, and J. Nathan Willemstein, and Lynn Giesler
Advisors: Dr. Michael Neuman and Dr. Keat Ghee Ong
Sponsor: Portage Health

2011

First Place

Capillary Refill Time Measurement Device

Team Members: Danielle Aerts, Jon Congdon, Katie Elicerio, Matt Johnson, and Justine Wiles, Biomedical Engineering
Advisor: Michael Neuman
Sponsor: Department of Biomedical Engineering

Second Place

Hand Washing Detector

Team Members: Beth Geerer, David Heiden, Jenna Joestgen, Liz Pietela, and Sam Wojda, Biomedical Engineering
Advisor: Seth Donahue
Sponsor: Department of Biomedical Engineering

2007

First Place

Design and Development of a CPR Mattress

Team Members: Andrew Delvaux, Josh Dykla, Chris Rivet, Matt Trembly, Biomedical Engineering
Advisor: Ryan Gilbert
Sponsor: Portage Health

Third Place

Effects of Stent Occlusions on a Coronary Arterial Side Branch

Team Members: Danielle McCabe, Paul Jermihov, Erik Rice, Jennifer Arnott, Biomedical Engineering
Advisor: Dr. Jeremy Goldman
Sponsor: Boston Scientific

View the full historical list of Expo award-winners dating back to 2002 online at www.expo.mtu.edu.

WAY TO GO: BME COMMENCEMENT SPEAKERS ABOUND

Over the past year or so, no less than three outstanding BME students have been invited by the dean of students to be commencement speakers. Here each one offers a word to the wise.

Drew Markel—Spring 2016

Markel, a Rochester, Michigan native, double majored in biomedical and mechanical engineering. He made the most of his time at Michigan Tech, or “Nerdvana”, as he warmly refers to it. This summer, he will start working in Family Care products at Kimberly Clark in Neenah, Wisconsin. “If you’re not the smartest or the best at what you’re doing, be willing to work hard. I throw myself at whatever challenges I face. I’m just your average kid, probably about the geekiest person you’ll meet, and I’m okay with it.”

Ellie Furmanski—December 2015

An Eden Prairie, Minnesota, native, Furmanski double-majored in biomedical and mechanical engineering, with a minor in Spanish. Soon after graduation she joined Boston Scientific—where she also interned—as a supplier quality engineer. “Don’t



Drew Markel '16

be afraid,” she said. “You will be successful and learn so much more about yourself and the world around you when fear is not a barrier.”

Melissa Mack—December 2014

Growing up in Dearborn, Michigan, Mack attended Michigan Tech’s Summer Youth Program. As an undergraduate she interned with GM, working in their Anthropomorphic Test Device Lab to develop more effective crash test dummies. She is now earning a master’s in mechani-

cal engineering. “We Huskies embrace our uniqueness and make the most of opportunities,” she said. “Instead of just trying to survive the winters, we throw Winter Carnival and play broomball.”

IN THE NEWS

Wired, a technology news magazine and website, reported on new, super-sticky adhesives made from mussel secretions, including research being conducted by Assistant Professor Bruce Lee: “Mussels’ Sticky Secretions Make for Super-Strong Adhesives.” Read the full article online at <http://www.wired.com/2015/11/mussels-sticky-secretions-make-for-super-strong-adhesives/>



“Bodies have a lot of water, which is why glues with DOPA (dihydroxyphenylalanine) could be useful to seal wounds or engineer tissues or form scaffolds for implants.”

Assistant Professor Bruce Lee in Wired, November 23, 2015

RECENT RENOVATIONS

Our biomedical engineering front office and student lounge have been updated and remodeled. Come by for a visit!



NEW FACULTY AND STAFF



Smitha Rao

Smitha Rao joins the BME department as an assistant professor. Before joining Michigan Tech, Rao was at the University of Texas at Arlington, where she received a PhD and Master's in Electrical Engineering. Rao has been featured on "Innovation Nation with Mo Rocca" on CBS Television. She holds patents for strain sensors and micro-windmills for energy harvesting. Her research interests include micro-electromechanical systems (MEMS), nanotechnology, implantable devices, microfluidics, and cellular dynamics.



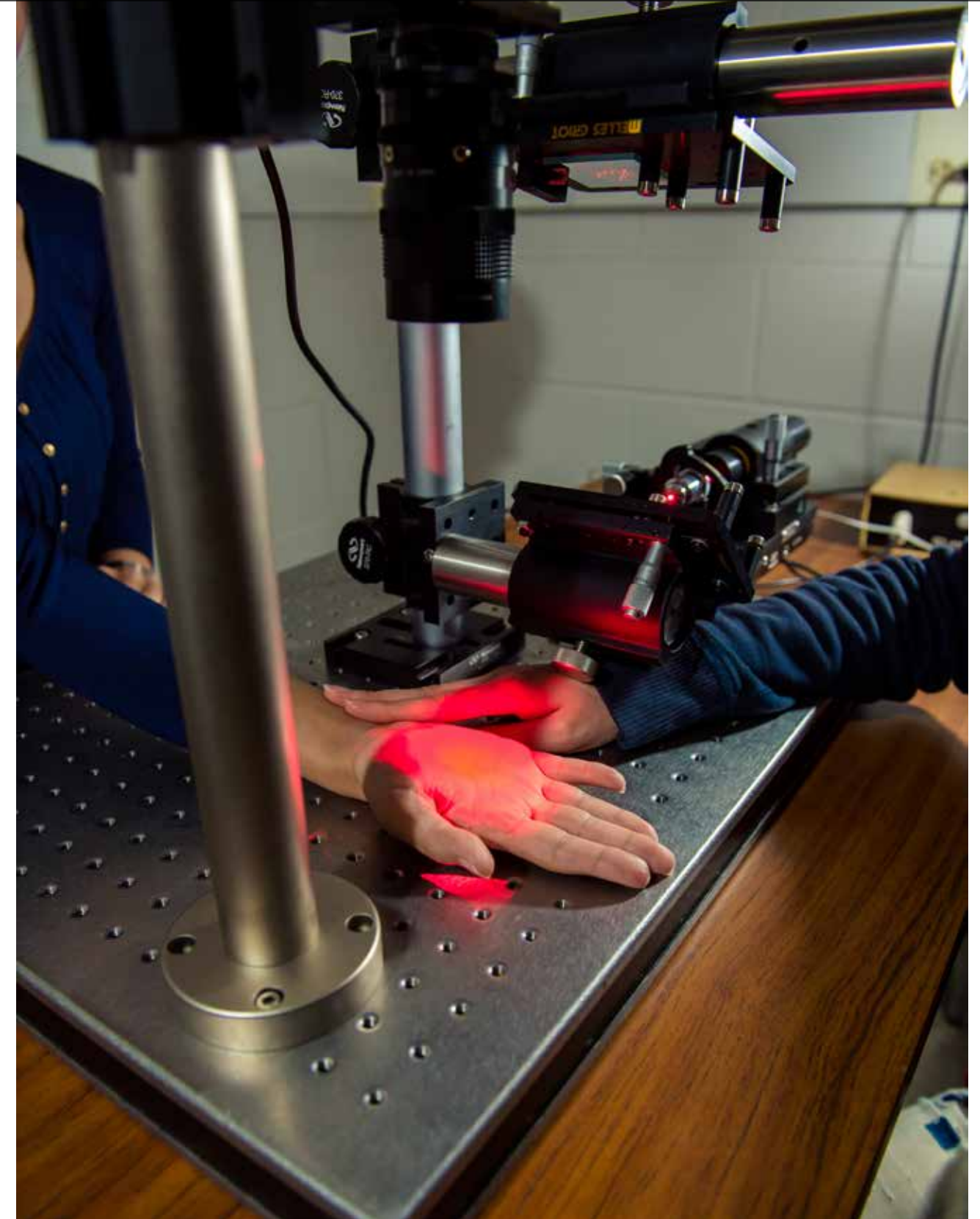
Orhan Soykan

Orhan Soykan joins the BME department as a professor of practice. He comes to Michigan Tech from Medtronic, Inc. where he held multiple positions in the Cardiac Rhythm Management Division and Corporate Science and Technology Department. He received his PhD in Electrical Engineering and Applied Physics from Case Western Reserve University in 1990, and Master's in Electrical Engineering from Michigan Tech in 1986. Prior to joining Medtronic, Soykan worked as senior biomedical scientist at the US FDA Center for Devices and Radiological Health. His research interests include implantable devices, biosensors, power and telemetry schemes, molecular medicine, cardiovascular medicine, and bioinformatics and proteomics.



(L) Stacey Sedar, departmental coordinator, comes to Michigan Tech from Range Bank in Lake Linden, Michigan. (R) Cory Dompier, office assistant, comes to Michigan Tech from Chassell Township Schools in Chassell, Michigan.

CARDIOVASCULAR ENGINEERING: SEAN KIRKPATRICK



Non-invasive assessment of blood perfusion and tissue oxygenation.

MAGNETOELASTIC FLOWER POWER: SENSING MORE WITH LESS

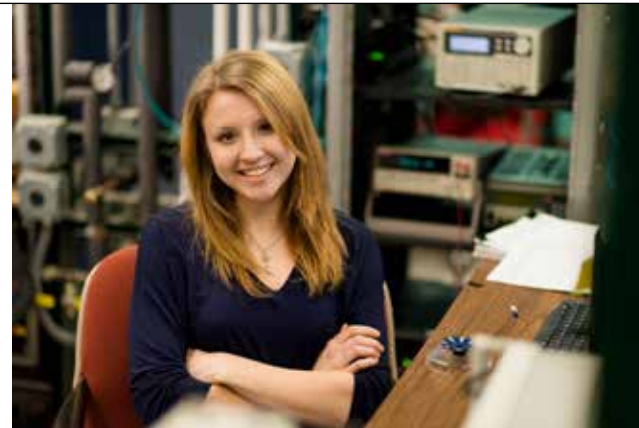
Nina Pacella stumbled upon the web page for the Michigan Tech Biosensors Lab, directed by Keat Ghee Ong. She was looking for an experience outside the classroom. “I knew nothing about research, or what it might take to work in a research lab, but everyone in the lab was extremely open to answering my questions,” she recalls.

Less than one year later, Pacella has developed a sensor array with high sensitivity for detection of various pathogens, and published a scientific paper about her work in the journal *Smart Materials and Structures*.

The sensor, which is disposable, can be used to perform rapid microbial detection. Potential applications include sensing *E. coli* for food quality and safety or monitoring hospital-acquired infections, such as MRSA.

“The array uses magnetoelastic properties to sense certain parameters in a target analyte,” Pacella explains. “Its flower design, comprised of triangular ‘petal-shaped’ magnetoelastic material, allows us to track multiple sensors at once. This type of sensor system is very low-cost and extremely quick. The ability to sense multiple samples at once cuts down sensing time, too,” she adds. “The triangle shape of the magnetoelastic materials is significant because it greatly increases the sensitivity of the sensor and is more streamlined, allowing for more sensors to be arranged together in a smaller area.”

To date, most magnetoelastic sensors are rectangular and are designed to sense a uniform coating of target analyte over the entire sensor surface. Pacella,



Ong and the research team developed a new magnetoelastic sensor design with higher sensitivity, achieved by applying non-uniform coatings and altering the sensor to a triangular shape. The new design allows the magnetoelastic sensor to form a sensor array that requires only a fraction of the sample volume for multi-parameter sensing compared to the current sensor design.

Pacella was responsible for characterizing the response of the triangle sensors, as well as designing and building the actual handheld sensor device to hold the triangles. “The design started out as very large and bulky. Through many revisions, we eventually ended up with the streamlined flower device,” she says. “I really enjoyed the design portion because it required use of our 3-D printer, and I thought it was especially rewarding to compare previous designs with the sensor as it is today.”

In addition to increased sensitivity, triangular magnetoelastic sensors can also be formed into a polar array with their tips concentrated in a small region. As a result, only a small quantity of test sample is needed for all sensors. Pacella and the team fabricated and tested a detection apparatus, including a new sensor holder, a spiral coil, and custom electronics to demonstrate the feasibility of this sensitive magnetoelastic sensor array with a minimized sample size. Their new design may lead to the development of biological or chemical sensors for the detection of glucose, pH, *Bacillus anthracis* (anthrax) and other pathogens.



Triangular sensors form a polar array, exposing the sample to all eight sensors.

CARDIOVASCULAR RESEARCH: JEREMY GOLDMAN



Normal appearance of arterial tissue prior to decellularization and extracellular matrix processing to produce a natural vascular graft material.

JEREMY GOLDMAN

Michigan Tech

Department of Biomedical Engineering
309 Minerals & Materials Engineering Bldg
1400 Townsend Drive
Houghton, MI 49931
Tel: 906-487-2772
Fax: 906-487-1717
Email: biomed@mtu.edu
www.mtu.edu/biomedical

Every so often, students who burn the midnight oil (and ours often do) need only step outside to catch a glimpse of the Northern Lights. Here the aurora is seen above the Minerals and Materials Engineering Building where our labs are located.

Want to make a gift to the Department of Biomedical Engineering?

Although Michigan Tech is a state-assisted institution, it receives less than one-third of its funding from state appropriations. Your gift helps keep our department on the cutting edge. There are two ways to give:

- Use Michigan Tech's online gift form at www.mtu.edu/givenow.
- Call the Michigan Tech Fund at 906-487-2310.

In order to make sure 100 percent of your gift goes to the Department of Biomedical Engineering, please specify the Biomedical Enhancement Support Fund 1454. Many, many thanks!

www.mtu.edu/biomedical

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PHOTO: VENKATA RAJESH CHUNDRU / VENKATARAJESH.NET