FALL 2018 | THE A. JAMES CLARK SCHOOL OF ENGINEERING

METRICS

MECHANICAL ENGINEERING AT MARYLAND

FROM ACADEMIA TO PRACTICE

How Mechanical Engineering's research centers are paving ways for success beyond the classroom

Chair's Message

Dear Friends,

Fall is upon us once again in College Park, as we embark on another academic year. In the Department of Mechanical Engineering, there is much to look forward to as students and faculty begin classes, engaging in multidisciplinary studies related to medical robotics, machine learning, big data and design, and sustainability energy and systems.

This is an exciting time for our department. In March, our graduate program was ranked 16th in the country by the *U.S. News & World Report*, the highest ranking it has ever achieved. In the Shanghai Jiao Tong University Rankings, we were ranked 25th among mechanical engineering graduate programs worldwide. On the eve of our 125th anniversary, we have plenty to celebrate, especially the department's terrific success in education and research.

In this year's METRICS, we highlight how the department's research centers are creating ways for success beyond the classroom. Through hands-on experience, applied research, interdisciplinary demand and social awareness, these centers have built a reliable bridge between academia and practice. Here, students and faculty can interact with industry, government and academic partners through research projects that have real-world applications and impact society.

In this issue, we also feature articles about current research in the department, including blood pressure monitoring devices that could enhance accuracy and accessibility, wood that is stronger than titanium alloy, inter-vehicle communication for cooperative adaptive cruise control, and an autonomous robot that has performed better at cutting soft tissue and stitching it up than experienced surgeons.

We also spotlight students, alumni and faculty who have been recognized with honors and awards. The issue covers our Terps Racing teams, which competed in five competitions and posted strong scores in a variety of contests. Also featured is a team called the Oyster Boys, which won the Design Day Sustainability Award.

We hope you enjoy this issue. As we prepare to celebrate our 125th anniversary, it is with great joy that we extend a sincere thanks to our alumni, friends and corporate sponsors for all they've done over the years to help us reach new heights.

B. Balachandran

Balakumar Balachandran
MINTA MARTIN PROFESSOR AND CHAIR
DEPARTMENT OF MECHANICAL ENGINEERING

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FROM ACADEMIA TO PRACTICE: A BRIDGE TO SUCCESS

The Mechanical Engineering Program at Maryland has built an enduring passage for students and research to make a smooth transition from academia to practice.

In what ways, can the classroom intersect with the real world? How can academia and industry work together to bridge the gap between theory and practice? What are the most pressing problems students will face in their fields, and how can they best prepare? These kinds of questions have been around for a long time. Yet for many students who graduate from the University of Maryland with a degree in mechanical engineering, the boundaries between research and practice have never been this close. In fact, you get the sense that these boundaries may barely exist.

"There has always been a demand for mechanical engineering graduates in automotive, energy, design, manufacturing, and the robotics areas," explains Department Chair and Minta Martin Professor Balakumar Balachandran. "The overall demand for mechanical engineering graduates has remained strong because of their versatility and the broad-based education that they receive. The horizon holds opportunities in a host of areas, including medical devices and health systems, autonomous systems and robotics, battery systems and energy systems, and machine learning applications."

On March 20, 2018, the Department of Mechanical Engineering's graduate program was ranked 16th in the country by the *U.S. News & World Report.* This was the highest ranking in the department's long history of 125 years. In the Shanghai Jiao Tong University Rankings, the department was ranked 25th among mechanical engineering graduate programs worldwide.

Together with its multidisciplinary curriculum and exemplary students and faculty, the impact of the department's four research and educational centers —the Center for Environmental Energy Engineering (CEEE), the Center for Advanced Life Cycle Engineering (CALCE), the Center for Risk and Reliability (CRR), and the Center for Engineering Concepts Development (CECD)—has been essential in bolstering the prestige of the department over the last two quarters of its 125 years of existence.

In each of these centers, students and faculty are offered unique opportunities to interact with industry, government and academic partners through state-of-the-art research projects. Often these projects, which begin in laboratories on campus, have served to position students very well in their fields of expertise after graduation.

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HANDS-ON EXPERIENCE

The Center for Environmental Energy Engineering (CEEE), which focuses on research related to air-conditioning, refrigeration and heat pumping and integrated cooling heating and power systems offers students a chance to pursue hands-on research and explore new ideas in energy conversion. The center faculty operate three consortia, including Energy Efficiency and Heat Pumps (EEHP), directed by Dr. Yunho Hwang; Advanced Heat Exchangers and Process Intensification (AHXPI), directed by Dr. Michael Ohadi; and Modeling and Optimization (MOC), directed by Dr. Vikrant Aute.

"The strength of our partnerships with industry and government has certainly been a major key to our success," says Minta Martin Professor Reinhard Radermacher, the director and co-founder of CEEE. "From project design to the development of new components and systems, we strive to produce results for our sponsors that exceed expectations. Our students gain a great deal of experience, which serves them well as they begin their careers."

Take, for example, Rohit Dhumane, a graduate student who worked on various projects at CEEE and is now finishing up his doctoral degree in mechanical engineering. Last summer, Dhumane gained hands-on experience at a manufacturing plant through an internship with Climate Control and Security, a heating, ventilation, and air conditioning (HVAC) manufacturer.

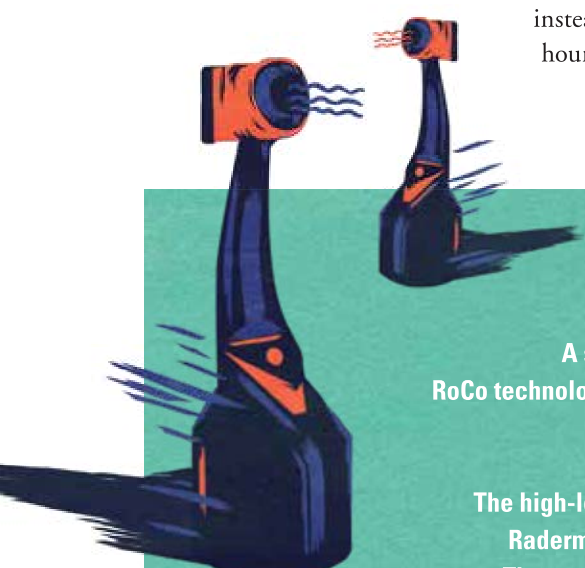
"It was a valuable experience," he says. "I learned that things in industry get done much differently than in a research lab at a university. For example, instead of taking 20 hours to set up all of the necessary instrumentation, it may take only 4 or 5 hours. The pace is different, the objectives are different and the outputs tend to be different."

Dhumane also worked on the development of a robotic cooling device called Roving Comforter, or RoCo. Sponsored by the Advanced Research Projects Agency-Energy (ARPA-E), the project involved enabling RoCo to follow around users while delivering cool or warm air, whichever was needed. In addition to the comfort benefit, the project also aimed to reduce energy consumption in buildings by up to 30 percent.

"My background and interest are in the modeling of systems, which I was able to utilize during this project." says Dhumane. "I worked on the modeling of heat storage. When the robot provides cooling, it stores the heat that is generated. I worked on modeling the processes and trying to understand the different factors that can help speed up the operation. I also worked on the controls, which allow you to see the temperature and humidity and other information at different points."

In the article, "Enhancing the thermosiphon-driven discharge of a latent heat thermal storage system used in a personal cooling device," published in the *International Journal of Refrigeration*, Dhumane and six other coauthors (including Dr. Radermacher), observe how RoCo consists of a compact R134a based vapor compression system for cooling and how phase change material (PCM) used as the storage medium provides high energy density by storing thermal energy as latent heat during the phase transition.

"The discharge rate is limited by the low thermal conductivity of the PCM," the authors explain. "Insertion of a graphite foam within the PCM can increase the rate of discharge and decrease the downtime of the cooling device."



COMMERCIALIZING ROCO AND CREATING JOBS

A startup company, Mobile Comfort, was recently established to commercialize the RoCo technology and bring it to the market. So far, Mobile Comfort has made steady progress in attracting follow-on investor funding for commercialization.

The high-level of expertise in CEEE has also helped create jobs in the state of Maryland. Dr. Radermacher, Dr. Hwang and Dr. Aute are shareholders of the consulting firm, Optimized Thermal Systems, located in Beltsville. The firm has 10 full-time employees and provides software and consulting in the area of energy efficiency and heat pumps.

APPLYING THE RESEARCH

The Center for Advanced Life Cycle Engineering (CALCE), which supports the development and sustainment of competitive electronic products, focuses on physics-of-failure (PoF) and machine learning approaches to reliability, accelerated testing, parts selection and upkeep, and supply-chain management. Its research areas include prognostics and health management (PHM) of electronic products, including batteries, smartphones, computers, industrial systems, and automotive and aerospace electronic systems.

CALCE's Electronics Products and System Consortium (EPSC) offers a forum for defining fundamental research needs, conducting research, and sharing research findings amongst participating organizations. It is supported by more than 150 companies in various sectors, including aerospace, automotive, avionics, computer and consumer electronics, government, medical, and military industries.

"Whether it's root cause analysis, materials characterization, or product test development, we continue to enhance and expand our advanced life cycle research and strive to improve electronic products and systems," says George E. Dieter Professor Michael Pecht, the director of CALCE. "Students have a wonderful opportunity here to work on projects in our Test Services and Failure Analysis Laboratory and engage with industry, government and other research groups. Many of them pursue a graduate degree in electronic products and systems."

According to Saurabh Saxena, who has worked for 4 years at CALCE and is in the process of completing his Ph.D. in mechanical engineering, modeling the behavior of batteries is an important part of predicting reliability and ensuring safety. "We've seen some recent problems with lithium-ion batteries," he says. "These batteries power e-cigarettes, smartphones, laptops and a variety of other products. Sometimes there are manufacturing defects and structural deformations that can cause premature capacity drop, swelling, explosions and fires."

These problems are difficult to detect by using conventional methods and analysis. A good portion of Saxena's research at CALCE has been aimed at developing an effective computed tomography (CT)-based nondestructive approach to assess battery quality and identify manufacturing-induced defects and structural deformations in batteries.

"Although lithium-ion batteries, compared to other batteries, have a higher energy density and a higher voltage and do not need as much maintenance, there are safety concerns related to flammable electrolyte and oxidizing agents," he explains. "Computed tomography gives you three-dimensional images across multiple length scales and allows you to inspect internal structural properties and analyze material densities, so this is very helpful for analyzing lithium-ion batteries."

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BATTERY RESEARCH: FAILURE AND RELIABILITY

Using a CT-based nondestructive approach, Saxena examined a faulty lithium-ion battery that was used in an e-cigarette and found welding burrs on the negative tab for exploded and fresh cells from the same vendor. He determined that during battery charge and discharge, the normal swelling and contraction of the electrodes could force the welding burrs into the opposing positive electrode and cause an internal short circuit, overheating the battery.

As part of his Ph.D. dissertation in collaboration with a leading computer technology company, Saxena is also working on the accelerated life testing of Li-ion batteries. The purpose of his research is to identify test conditions for battery qualification, which can accurately estimate battery reliability in the shortest possible time.

INTERDISCIPLINARY DEMAND

The Center for Risk and Reliability (CRR) is focused on a wide breadth of topics involving systems and processes. CRR researchers may pursue risk analysis theory and applications to complex systems such as civil infrastructures, information systems, medical devices, nuclear power plants, petro-chemical installations, civil aviation and space missions. Predictive reliability modeling and simulation, physics of failure fundamentals, software reliability and human reliability analysis methods, advanced probabilistic inference methods, system-level health monitoring and prognostics are also important areas of CRR research.

The center is also the research arm of the Reliability Engineering educational program, through which students are offered an M.S., Ph.D, and Graduate Certificate in Reliability Engineering and Risk Analysis.

"Reliability engineering is essential to so many fields," says Dr. Vasiliy Krivtsov, an Adjunct Associate Professor of Reliability Engineering and Director of Reliability Analytics at Ford Motor Company. "Students who graduate from the program are in high demand because of the interdisciplinary nature of reliability and risk analyses and because of their mathematical and statistical knowledge."

Krivtsov, who graduated from UMD's Reliability Engineering program in the late 1990s, was invited to teach in the program by Nicole Y. Kim Eminent Professor Mohammad Modarres, who is a director and cofounder of the program. "Professor Modarres also asked me to write a book with him," he recalls. "Now I use that textbook with my students."

The book, *Reliability Engineering & Risk Analysis*, is now in its third edition and Krivtsov says is being used at various universities throughout the world. "The book has been sent to Spain, England, Russia, Australia and other countries," he says.

During the spring semester, Krivtsov flies weekly from Ann Arbor, Michigan, where he works at the Ford Motor Company, to College Park, Maryland to teach a graduate course in the program. Last spring, he taught Collection and Analysis of Reliability Data (ENRE 640), which focuses on nonparametric and parametric statistical procedures of reliability data analysis for both non-repairable and repairable systems.

"I back up theoretical formulas with actual case studies from my own experience in the industry," says Krivtsov. "Students have told me they really appreciate this practical flavor because they can see how relevant these theoretical formulas are, what kinds of decision-making they support and the influence they have in industry."

This fall, Modarres is launching a new elective class on autonomous systems and has asked Krivtsov to bring him and his students to the Ford Motor Company. "You know that every automaker nowadays has an autonomous driving department where they develop all kinds of algorithms," he says. "I can't wait to show them what Ford is doing in this space. And, of course, we would certainly be interested to see if whatever develops through that course can be utilized at Ford in a collaborative way through a proper agreement."

HYDROGEN RISK AND RELIABILITY RESEARCH

The Center for Risk and Reliability also conducts risk and reliability research on hydrogen fuel infrastructure and hydrogen vehicles. Hydrogen fuel cells produce zero-emissions, which is a strong incentive for using them in transportation and portable power applications. CRR is assessing hydrogen risk and reliability in a number of areas, including storage, delivery, and distribution. A main application of the research is helping to advance hydrogen codes and standards, as well as models and data to enhance a larger understanding of hydrogen safety.

SOCIAL AWARENESS

Comprised of an interdisciplinary team of faculty, staff and students, the Center for Engineering Concepts Development (CECD) is focused on engineering education, future technologies, the impact of engineering on society, and various areas of research. Some of these research areas include energetics, sustainability, nanotechnology, design via crowdsourcing, heat transfer applications in space, autonomy, and advanced computational techniques.

"What I really appreciate about CECD is that it experiments with ideas in engineering education and research in the context with how they affect society," says Christine Bersabal, who conducted research at CECD and graduated last year. "As engineers, we have a desire to build and design, but how do we do that responsibly if we don't consider our intended or unintended consequences? Everyone has a personal device but we don't really consider where it goes when we're done with it. That's just one example of how CECD thinks outside of the box and why I believe it will continually connect with industry demands."

Since 2015, CECD has offered a course called Engineering for Social Change (ENME 467), which was created by Professor Emeritus and CECD Director Davinder Anand and Assistant Director Dylan Hazelwood. Through this course, issues are examined at the intersection of engineering, philanthropy and social change. Some of the topics include ethics and the impact of electronics on society, sustainability and climate change.

Anand and Hazelwood, as well as Michael Pecht and Mukes Kapilashrami, wrote the book, *Engineering for Social Change: Engineering Is Not Just Engineering*, which is used in the course. "Young engineers often find it more fulfilling to make a positive social impact, instead of just working towards increasing profits for their employer," the authors write.

Ask Christine Bersabal what she took away from the course and she'll tell you that the possible career paths in engineering are endless and do not always have to be technical. "The class is atypical from the core curriculum in engineering as it focuses on soft engineering skills and not technical skills," she says. "Most guest lectures emphasized the importance of soft skills in engineering, because while engineers do excel at math and science, there is also a need to understand the social implications of our ideas."

The research skills that Bersabal gained through her CECD internship were instrumental in helping her land her current position as a patent examiner for the US Patent and Trademark Office. "To examine patent applications, sometimes I have to be creative when finding prior art similar to a case on which I am working," she explains. Bersabal also credits her CECD internship in helping her learn how to write and report out technical findings and methods to an audience that might not come from an engineering background. "I am also in communication with attorneys," she points out.

But ultimately what makes her most excited about the work she does?

"I am at the forefront of innovation. It's really cool to see new inventions and be one of the first to hear about it. These inventions then go off to affect society in big and small ways. This puts quite a responsibility on me, but I am very grateful for the opportunity."

RAISING AWARENESS ABOUT ELECTRONIC WASTE

Bersabal's internship at CECD exemplified a need for social awareness. "At CECD I worked with two other interns to complete a research project on electronic waste," she says. "My role focused on how to use GPS to track electronic waste when dropped off at a recycling facility. It was interesting to learn how we recycle (or don't recycle) electronic waste, and I felt a responsibility to be an ethical engineer."

Cuff, Scale, and Smartphone

New blood pressure monitoring technologies could enhance accuracy and accessibility. New research by Jin-Oh Hahn, a recently promoted associate professor in the Department of Mechanical Engineering, in collaboration with Professors Ramakrishna Mukkamala at the Michigan State University and Omer Inan at the Georgia Institute of Technology, is paving a way toward new affordable, ultra-convenient, and patient-specific approaches to monitor blood pressure and cardiovascular risk predictors.

THE SUPER CUFF

The "super cuff" is a suite of algorithmic technologies Hahn and his colleague Mukkamala are developing to advance the capability of conventional blood pressure cuff devices by enabling the monitoring of advanced cardiovascular risk predictors as well as traditionally measured brachial blood pressure.

The super cuff uses patient-specific algorithms.

"It is based on the conventional cuff, but the algorithms inside of it can adapt blood pressure and cardiovascular risk predictor computations to individual subjects and potentially improve the accuracy of the readings," says Hahn.

According to Hahn, the patient-specific algorithms in the super cuff may enable more accurate automatic cuff blood pressure measurement in patients with large artery stiffening while limiting the number of required cuff inflations or deflations per measurement, as well as monitor cardiovascular risk predictors whose measurement used to necessitate expensive equipment and trained operators.

THE SCALE

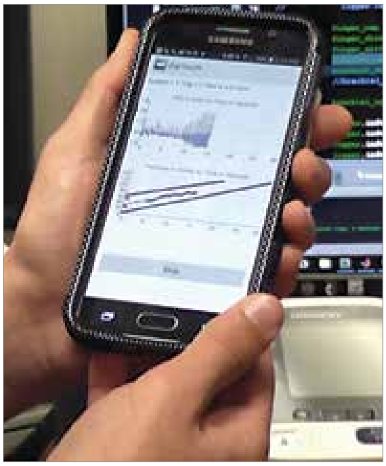
In an effort to improve the tracking of blood pressure in individual subjects, Hahn in collaboration with Mukkamala and Inan has also pursued research to assess the capabilities of a weighing scale-like system to calculate pulse transit time through larger and more elastic arteries by measuring ballistocardiography and foot photoplethysmography waveforms.

"We don't require the user to do anything," says Hahn. "You stand on it and that's it."

The scale is equipped with sensors that measure the subject's small-amplitude vertical movement that occurs in response to an ejection of blood from the heart. "Each ejection of blood by the heart causes movement of the body," explains Hahn. "Although this amplitude is very small, we can measure it and translate that signal into a blood pressure reading."

The weighing scale-like system can calculate pulse transit time.

Hahn and his colleagues found that the weighing scale-based pulse transit time is a better marker of blood pressure than conventional pulse arrival time widely being pursued. Their work involved measuring the scale pulse transit time, conventional pulse arrival time, and cuff blood pressure in humans during interventions that increased blood pressure but changed the pre-ejection period and smooth muscle contraction differently.



This smartphone can measure blood pressure.

THE SMARTPHONE

Since convenience is a big factor, Hahn also worked with Mukkamala in developing a smartphone-based system that can conveniently measure blood pressure. The idea is to allow people to check their blood pressure anytime and anywhere.

"We came up with a system including a smartphone encasing and an app that is simple enough to use to evaluate the validity of our idea," says Hahn. "We demonstrated that it is certainly feasible to check your blood pressure with a smartphone. This convenience allows people to check their blood pressure as often as they like, wherever they are."

The technology is activated when the user presses a finger against the smartphone and the external pressure of the underlying artery is steadily increased. The smartphone then measures the applied pressure and resulting variable amplitude blood volume oscillations. To guide the amount of external pressure applied over time through the finger pressing, users receive visual feedback from the smartphone, which computes systolic and diastolic blood pressure from the measurements.

SUPER WOOD COULD REPLACE STEEL

STRONGER, TOUGHER, LIGHTER AND LESS EXPENSIVE—SUPER WOOD HAS POTENTIAL FOR USE IN CARS, AIRPLANES, BUILDINGS, ETC.

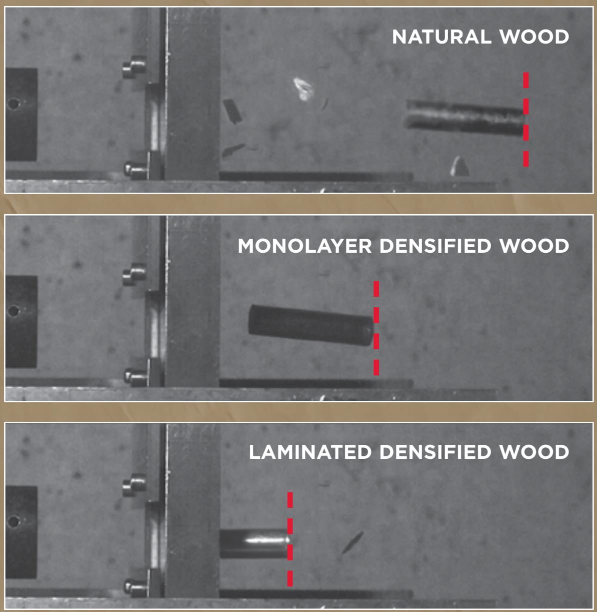
Engineers at the University of Maryland in College Park have found a way to make wood more than ten times stronger and tougher than before, creating a natural substance that is stronger than titanium alloy.

"This new way to treat wood makes it 12 times stronger than natural wood and 10 times tougher," says Associate Professor Liangbing Hu, leader of the research team. "This could be a competitor to steel or even titanium alloys, it is so strong and durable. It's also comparable to carbon fiber, but much less expensive."

The team's process begins by removing the wood's lignin, the part of the wood that makes it both rigid and brown in color. Then it is compressed under mild heat, at about 150 F. This causes the cellulose fibers to become very tightly packed. Any defects like holes or knots are crushed together. The treatment process also involves a coat of paint.

"It is both strong and tough, which is a combination not usually found in nature," says Associate Professor Teng Li. "It is as strong as steel, but six times lighter. It takes 10 times more energy to fracture than natural wood. It can even be bent and molded at the beginning of the process."

The scientists found that the wood's fibers are pressed together so tightly that they can form strong hydrogen bonds, like a crowd of people who can't budge—who are also holding hands. The compression makes the wood five times thinner than its original size.



In an experiment to test strength and resistance, a bullet was shot through natural wood, monolayer densified wood, and laminated densified wood, or Super Wood. Only Super Wood could stop the bullet from going all the way through.

Haptic Safety for Unmanned Vehicles

UMD RESEARCH ADVANCES NETWORKED CONTROL AND VIRTUAL REALITY FOR ADDED SAFETY.

This scaled-down vehicle can be controlled remotely.

Even as fully automated vehicles continue to be tested and used on roadways, there will likely still be a need for human involvement. Anticipating this need, Nikhil Chopra, an associate professor in the Department of Mechanical Engineering, is working on in-vehicle technology that will summon help in certain environments.

"We are developing a secure tele assist feature that can send an alert about unknown surroundings, so a driver can take control of the car from a remote location for added safety," Chopra explains. In driving environments that call for flexibility and a high-level of decision-making, a human would currently be a better bet than a machine. A scenario where there is road construction and a detour that forces the vehicle into unfamiliar territory is a good example of this, according to Chopra. "In this case, someone would assume control of the wheel and pedals remotely to navigate through this environment," he says.

HOW IT WORKS

Remember that childhood game Simon Says? The one by Milton Bradley? You follow the flashing lights (red, blue, yellow and green) and try to imitate the sequence. The machine compares your selections to its own. The challenge is to remember all the flashing colors in the right order.

Flash forward to today and reverse the roles. Now a machine can imitate you in real-time. Now you can hold a joystick or data glove to communicate tactile sensations to cars and robots and use this capability to improve efficiency while advancing safety.

With haptic devices, humans can interact with computers by sending and receiving information through felt sensations. This is the kind of work that Chopra has been spearheading in recent years. A good portion of his research in the automotive domain aims to advance networked control for connected semiautonomous vehicles and virtual reality-based multimodal learning in self-driving cars.

COLLISION AVOIDANCE

"The work involves using inter-vehicle communication for cooperative adaptive cruise control with safety features such as collision avoidance," Chopra explains. "The goal is to enhance the safety of current adaptive cruise controls while improving the driving experience."

A vehicle equipped with adaptive cruise control can maintain a safe distance from the vehicle ahead of it through technology that automatically adjusts its speed. This is especially beneficial on high volume roadways and stop and go traffic. Cooperative adaptive cruise control expands on this capability by allowing vehicles to talk to each other through dedicated short-range communication, enabling cooperative and synchronous braking and acceleration.

Using visual and haptic data, Chopra is also studying the automatic synthesis of acceleration and steering commands. "We are creating a virtual reality system to enable multimodal imitation learning," says Chopra. Some of the equipment in this system includes a steering wheel and foot pedals that control a scaled-down vehicle. The experience is similar to driving a car except you operate it remotely.

Using a steering wheel and foot pedals, this driver operates a scaled-down vehicle remotely.

RAISING THE BAR ON PRECISION

Surgeons are trained to be precise and effective. Their work demands that they stay alert and perform to the best of their ability. After all, lives may be at stake. But what if they had some help? The kind of help that is reliable and consistent. What if they could use a robot to do the incisions and suturing while they monitored the activity?

Enter the Smart Tissue Autonomous Robot, or STAR, which has performed better at cutting soft tissue and stitching it up than experienced surgeons, who deviated more from the ideal cut line and caused more char.

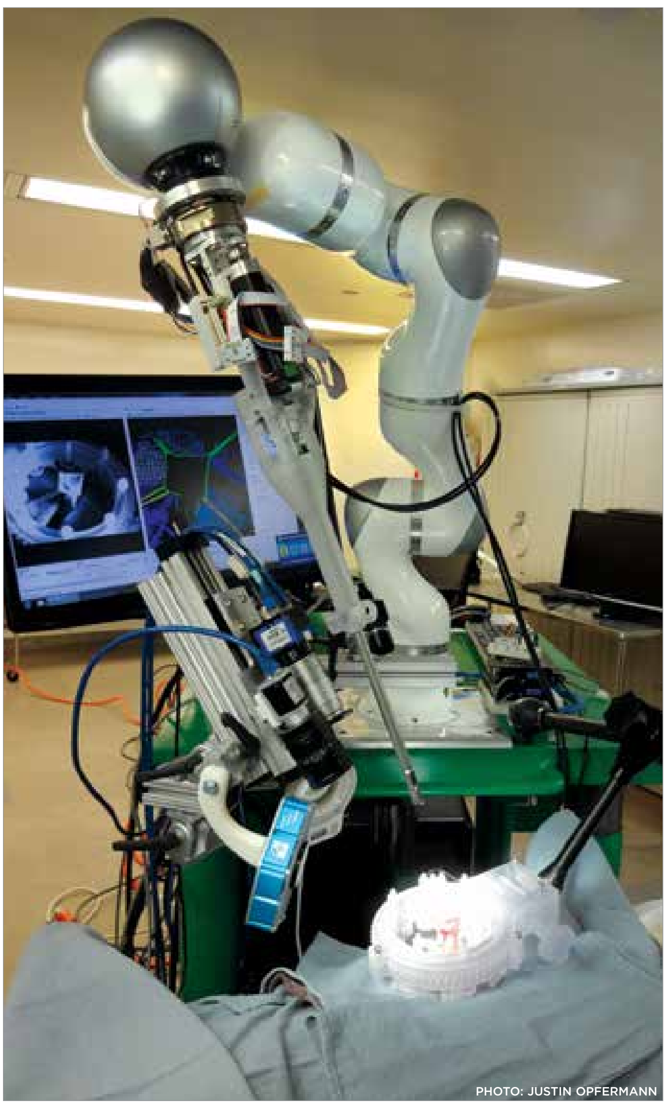


PHOTO: JUSTIN OPFERMANN

The STAR visually tracks its cutting path and cutting tool while adjusting to movement.

"The STAR is really good at doing repetitive procedures that require a lot of precision," says Axel Krieger, an assistant professor of mechanical engineering at the University of Maryland. "If you miss one suture, for example, that may create a leak and cause problems. The STAR can prevent this from happening because it can perform this task precisely and without errors each and every time."

A few years ago, the STAR proved it could do better than experienced surgeons at stitching together two segments of pig intestine. The stitches were more regular and leak-resistant. The STAR not only has tools for suturing, but also for fluorescent and 3D imaging, force sensing, and submillimeter positioning. It also has demonstrated that it can make precise cuts in irregular soft tissue.

The STAR visually tracks its cutting path and cutting tool while adjusting to movement. Using its near-infrared camera, it follows tiny marks placed on the tissue beforehand to keep on track during cutting. Researchers programmed the STAR with the ideal cut setting for porcine tissue and compared the robot against expert surgeons using open and laparoscopic techniques in a line cutting task.

> The Smart Tissue Autonomous Robot has performed better at cutting soft tissue and stitching it up than experienced surgeons.

They then performed a proof of concept demonstration using the STAR to semi-autonomously resect pseudo-tumors in porcine tissue using visual servoing. When tasked to excise tumors with a consistent 4 millimeter margin, they found that the STAR can semi-autonomously dissect tissue with an average margin of 3.67 millimeters and a standard deviation of 0.89 millimeters.

"We still have a long way to go," says Krieger. "Currently we get feedback from a surgeon for every procedure we do. We hope that as we get better and more robust we'll need less and less feedback."

PHOTO: TERPS RACING

The Terps Racing Baja SAE team posted strong scores for each of the single's contests.

Another Great Year for Terps Racing Teams

It was another successful year for the A. James Clark School's Society of Automotive Engineers (SAE) Terps Racing teams. The Terps Racing Baja SAE team, which competed in all three 2018 US competitions (in Maryland, Kansas and Oregon), posted strong scores for each of the single's contests; in every competition, the team ended up only one spot from qualifying for the coveted Design Finals bonus event. The Terps Racing Formula SAE team, which competed in all events in two competitions, placed 92nd out of 114 in Michigan and 39th out of 67 in Nebraska.

In the Baja SAE Maryland competition, held April 19–22 in Mechanicsville, the team placed 16th overall, and in the Baja SAE Kansas competition, held May 17–20 in Pittsburg, the team did even better, finishing 15th overall. The team also placed 36th overall in the Baja SAE Oregon competition, held May 30–June 2 in Portland. Between the Baja SAE Maryland and Baja SAE Kansas competitions, the team installed a completely overhauled powertrain system (a new transmission, static-ratio gearbox and gears, differential, and in-board CV-joints) a light-weighted braking system, and new suspension settings designed to complement the team's differential choice.

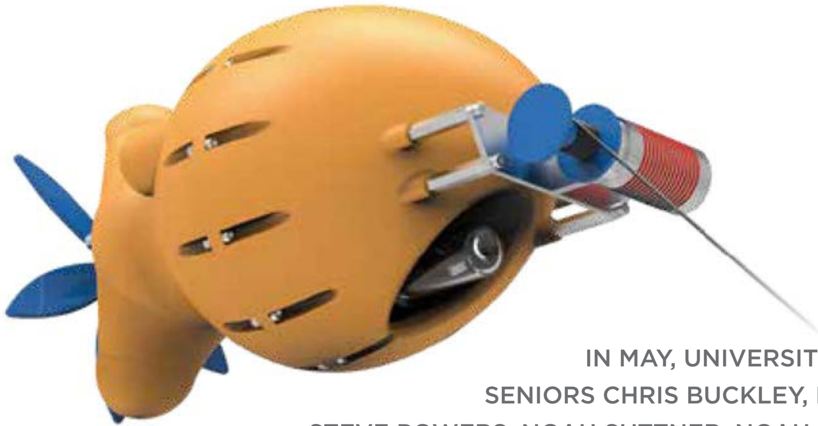
"We improved our recent design scores as well as built a strong set of team documentation, training, databases, and passed-on knowledge that has allowed us to gain a stronger command of the engineering principles behind our vehicle," says Baja SAE Team Leader Jaime Berez. "Hopefully these placings are a sign that the team is ready to push more advanced designs in the next few seasons."

The Terps Racing Formula SAE team, which competed May 9–12 in Brooklyn, Michigan and June 20–23 in Lincoln, Nebraska, faced manufacture and design challenges throughout the year, but was able to field a competitive vehicle that built upon the successes of the 2017 racing season and competed in all events of both competitions. The team gained valuable experience this year and is very excited for next year's racing season. It has synthesized the lessons it learned from this season into a set of organizational and engineering goals that will help to build a foundational platform for future success.

Terps Racing is an organization of about 100 students that design, build, test, and race a formula-style and baja-style racecar in collegiate design competitions each year. Through the design, build, and testing process, students gain experience in computer aided design modeling, finite element analysis, computational fluid dynamics, design analysis and testing and leadership skills. During competition, industry professionals examine the car's design—from marketability and cost to performance and engineering.

PHOTO: TERPS RACING

The 2018 Terps Racing Formula SAE team.



IN MAY, UNIVERSITY OF MARYLAND SENIORS CHRIS BUCKLEY, PATRICK O'SHEA, STEVE POWERS, NOAH SUTTNER, NOAH TODD, AND KYLE THIBEAULT WON THE DESIGN DAY SUSTAINABILITY AWARD FOR A DREDGE DETECTION DEVICE THEY BUILT THAT USES SENSORS TO DETECT ILLEGAL DREDGING AND ALERTS AUTHORITIES WHEN THIEVES ARE STEALING OYSTERS.

OYSTER BEACON TARGETS SUSTAINABILITY

Design Day, which is the culmination of the Department of Mechanical Engineering's Integrated Product and Process Development Course, featured 33 teams of senior-level students who presented project prototypes built to solve selected engineering problems.

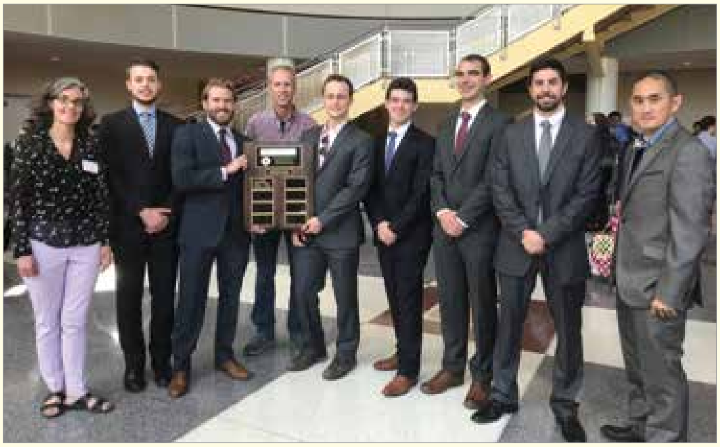
Under the direction of Assistant Professor Mark Fuge, the team, called the Oyster Boys, developed the dredge detection device over the course of the spring semester. "Our product is essentially an underwater microphone that detects the noise that the dredge makes when poachers are stealing oysters," says Kyle Thibeault.

In an effort to mitigate theft in oyster sanctuaries and private oyster farms in the Chesapeake Bay, the team created a floating beacon that detects dredging using a hydrophone. "We actually 3D-printed the housing of our beacon," explains Thibeault. "The beacon sits about 10 feet above the Bay floor and has a pulley on the front of it that allows it to go up and down in the water. So once it hears a dredge, it releases itself to the top and then the atmospheric pressure sensor turns on a GPS locator that alerts authorities of its location."

In researching the poaching problem, the team found that even though Maryland taxpayers invest $1.5 million annually in the restoration of oysters in designated sanctuaries, 80 percent of these sanctuaries are poached every year. Oysters are essential to the health of the Chesapeake Bay's ecosystem; they filter the water as they feed, helping to keep the bay clean for underwater grasses and other aquatic life.

The team first tested the prototype in a swimming pool to see if it could pick up sounds underwater. "Then we made improvements and tested it in the Chesapeake Bay," says Noah Todd. "This gave us an understanding of the hydrophone's performance and the different sounds in the bay. So we were then able to isolate and identify the sounds of dredging."

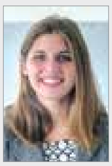
Implementing enhancements to the device and creating a more advanced prototype would be the next step, if the team decides to move forward with it. The University of Maryland's Office of Technology Commercialization is currently exploring the prototype's potential for real-world applications and deployment.



The Oyster Boys created a floating beacon that detects dredging using a hydrophone.

STUDENTS RECEIVE DEAN'S AWARDS

Three undergraduate students from the Department of Mechanical Engineering were honored at the 2018 Annual Engineering Honors and Awards Ceremony for their outstanding excellence in academics, leadership and service.



HAROULA TZAMARAS is the recipient of the A. James Clark School of Engineering Dean's Award. A ME major who is minoring in International Engineering, she is a member of the QUEST Program and an alumna of the Flexus Program. Tzamaras has been a teaching fellow for the engineering school, the business school and Education Abroad.

JEFFERY O'NEAL is the winner of the A. James Clark School of Engineering International Student Award. O'Neal is a ME major, pursuing minors in Spanish and Project Management. He is a member of the University Honors Program, RISE Leadership Academy and Engineers Without Borders.

RACHEL ROMANO is the recipient of the Dinah Berman Memorial Award. Romano is a ME major who is minoring in Sustainability Studies. She is a member of the University Honors Program and the RISE Leadership Academy. Romano is also a co-leader of the solar sub-team within the Sierra Leone project group for Engineers Without Borders. She also works at the Engineering Career Services Office as a peer advisor.

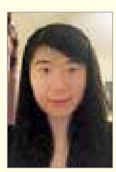
Five Mechanical Engineering Graduate Students Named Future Faculty Fellows

Five graduate students from the Department of Mechanical Engineering have been named to the 2018 A. James Clark School of Engineering Future Faculty cohort. The Future Faculty program selects current doctoral candidates and prepares them for long-term career success in the academic world as educators and researchers.

MARTIN ERININ is a Ph.D. student studying with advisor Professor James Duncan in the Hydrodynamics Laboratory. His research focuses on the development of particle sizing measurement techniques and applying these techniques to various multiphase flow phenomena.

ZAHRA GHASEMI is a third-year Ph.D. candidate in the Department of Mechanical Engineering under the direction of Associate Professor Jin-Oh Hahn in the Laboratory for Control and Information Systems. Her research involves developing innovative, convenient and affordable methods to increase health monitoring.

HEE-SUP SHIN is a Ph.D. candidate studying with advisor Associate Professor Sarah Bergbreiter in the Micro Robotics Laboratory. His research is focused on improving soft capacitive strain sensors in terms of sensitivity, hysteresis, and bandwidth and developing a sensing skin embedded with the soft strain sensors for aerial robots.



GUANJIN WANG is a third year Ph.D. candidate under the guidance of Chair and Minta Martin Professor Balakumar Balachandran and Associate Professor Amir Riaz. Her research focuses on modeling and analysis of granular systems, specifically multiscale and multi-phase problems occurred during dynamic interactions. Wang extends novel mesh-free simulation tools to the field of terra mechanics, which captures the complex behavior of granular soils under locomotion across phases and topology.

YANBIN WANG is a Ph.D. candidate studying under Assistant Professor Siddhartha Das. His research focuses on uncovering the fundamentals of interactions of water and structurally defective graphene (SDG). Interaction of such SDG [e.g., holey graphene (HG) or graphene with grain boundaries (GWGB)] water is crucial for a large number of applications ranging from water desalination to enhanced heat transfer.

Program members take three one-credit training seminars, a teaching practicum and a research mentoring practicum. The three main objectives are to increase the number of qualified future teachers that will graduate from the Clark School, prepare selected doctoral students to achieve career-long success in the academic world as both teachers and researchers, and to place selected students in leading institutions and continue to partner with the University of Maryland.

Engineering for Social Change Class Awards $10,000 to Oyster Recovery Partnership

During a ceremony in December at the University of Maryland, students in the Engineering for Social Change course awarded the Oyster Recovery Partnership $10,000 to support their goal to increase oyster population in the Chesapeake Bay. The grants for the class are funded through generous support from the Neilom Foundation, a non-profit focused on improving the lives of young people through the intersection of education and technology.

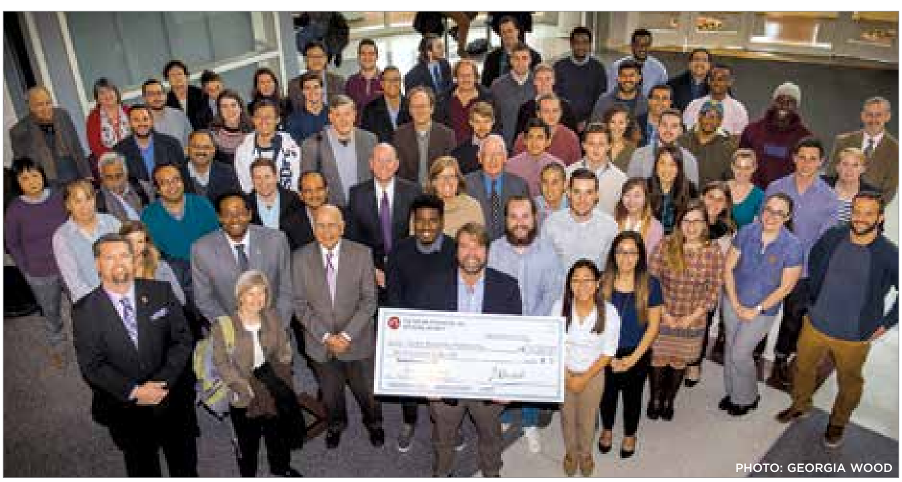


PHOTO: GEORGIA WOOD

In December, students awarded the Oyster Recovery Partnership $10,000 to support their goal to increase oyster population in the Chesapeake Bay.

Now in its fourth iteration, the class has given more than $40,000 to local nonprofits. Engineering for Social Change was established by Professor Emeritus Davinder K. Anand in 2015 to encourage students to consider the social impact of engineering. A central theme of the course is unintended consequences, both positive and negative, and how engineers can consider them moving forward into their careers. This year, the problem area addressed by the class was waste, and the nonprofit organizations selected were targeted for their activities in mitigating waste in the State of Maryland.

The Oyster Recovery Partnership (ORP) works within the Chesapeake Bay to increase overall oyster population. To combat the impact of urbanization and agricultural waste pollution on the oyster population, ORP deploys spat on shell in the bay. In 2016, they deployed over 835 million spat on shell and worked with commercial watermen to place 270,000 bushels of shell on public oyster reefs.

With the Engineering for Social Change grant, ORP plans to implement a large hopper and conveyer belt to alleviate shell breakage in the cleaning stage of their process. The group estimates that 15 percent of their shells become broken and unusable in the cleaning process. To decrease shell loss, the new hopper will increase the quantity of shells that could be fed into the cleaning system and limit excessive handling of shells.

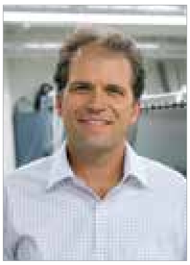
"We are honored to be the fourth recipient of the Engineering for Social Change grant award, and eager to put this funding to good use," ORP's Director of Program Operations Ward Slacum. "This grant will allow us to improve our oyster shell handling process to conserve more shell and, therefore, improve more oyster habitat annually. We offer a huge thank you to the students for recognizing the ecological value of shell recycling and the Neilom Foundation for supporting projects such as this."

This year, student groups worked with nonprofits to create the proposal to present to the class. These nonprofits included the Waterfront Partnership of Baltimore, Community Food Rescue and the Food Recovery Network, among others. In previous iterations of the class, interested groups contacted the class to submit proposals for the award.

Throughout the semester, students in the Engineering for Social Change course heard from guest speakers at the intersection of engineering, philanthropy and social justice. Some of the topics discussed in the lectures included social media, the social impact of 3D printing and waste to energy.

DeCaluwe and Chauhan Recognized with Early Career Awards

Mechanical Engineering alumnus Steven DeCaluwe (Ph.D. '09) was named a 2017 Department of Energy (DOE) Early Career Research Program recipient and alumna Preeti Chauhan (MS/PhD '12) was named the 2017 Early Career Award recipient by the A. James Clark School of Engineering.



DeCaluwe's award is given through DOE's Office of Science and supports the development of the individual research programs of engineers or scientists early in their careers. DeCaluwe is an Assistant Professor of Mechanical Engineering at Colorado School of Mines. Through this award, he will receive $750,000 to support his research in the development of novel neutron scattering experiments to improve functional polymers used in hydrogen fuel cells and lithium air batteries. This research aims to enhance the efficiency of energy devices used in electric vehicles.

"I'm incredibly and honored by this award from DOE, which is going to enable some truly groundbreaking neutron scattering work to identify and understand the role of functional polymers in electrochemical energy devices such as lithium-air batteries and PEM fuel cells," says DeCaluwe. "By conducting neutron scattering measurements during device operation, we will be able to study polymer surfaces and chemical gradients away from equilibrium. This, in turn, will let us identify rate-limiting processes and degradation mechanisms to ultimately improve device performance."

DeCaluwe has been at Mines since 2012, following a National Research Council postdoctoral fellowship at the National Institute of Standards and Technology (NIST). During his time at Maryland, DeCaluwe researched cerium oxide as a catalyst in solid oxide fuel cells with both experimental work and mathematical modeling.

"The strong connections between UMD and NIST in Gaithersburg, MD, helped me get involved with the neutron scattering community, in the first place," says DeCaluwe. "I look back fondly at my time in Mechanical Engineering at UMD, and view it as a department truly invested in building the engineering leaders of tomorrow."

Chauhan's award honors a Clark School alumnus or alumna who has achieved meritorious contributions and significant rapid advancement in the early stages of his or her career. Chauhan was chosen based on a wide range of criteria, including "extraordinary spirit and enthusiasm in promoting the Clark School."

Since graduating in 2012, Chauhan has served in different capacities at the Intel Corporation in Tempe, Ariz. Currently she is a Quality and Reliability Program Manager in the Assembly Test and Technology Development division at Intel Corporation. Her job involves providing technical leadership to a team of 15 engineers in the area of semiconductor packaging to drive quality and reliability certification of Intel's XEON server microprocessors. While at the University of Maryland, her research focus was on reliability of solder joints and areas of copper wire bonding and prognostics and health management of electronics.

Chauhan's nomination was supported by Dr. Diganta Das, an Associate Research Scientist in the Department of Mechanical Engineering. With this honor, Chauhan joins other distinguished mechanical engineering alumni who have won awards from the Clark School.

Helping Young Engineers Grow

Alumnus Paul Lara (B.S. '01) has had a big impact on engineering. As the head of a ship design and build team for the United States Navy, Lara has been a mentor and a role model to numerous engineers.

"Mentoring new engineers is a great way to help them grow and find their career path," says Lara, who is pursuing a Ph.D. at UMD focused on Fatigue Failure of Materials. "Being an engineer includes being in service to others and mentoring them provides that service."

After completing his bachelor's degree at UMD, he served 4 years in the Navy, where he now works, but as a civilian. According to Lara, new engineers need autonomy to do things on their own and need to feel empowered to tackle challenges.

They also need to be able to help and support others. "There isn't a class for that, you have to build that," he says. "As a leader, I try to take care of things for my engineers so they can concentrate on their job and their growth. I like to empower new engineers to do things and have ownership of their tasks and responsibilities."

Lara expects to defend his dissertation next fall and graduate in December 2019. And there's more: "He's a fantastic father to our 12-year old daughter, Olive, and our sweet dog, Jedi," says his wife, Jen. "He's also a big Star Wars fan and an avid mountain and road biker."

Nancy Margolis (M.S. ’80) received the A. James Clark School of Engineering Glenn L. Martin Medal.

MARGOLIS AWARDED CLARK SCHOOL GLENN L. MARTIN MEDAL

Department of Mechanical Engineering alumna Nancy Margolis (M.S. ’80) has been named a 2017 recipient of the A. James Clark School of Engineering Glenn L. Martin Medal. This award, given once a year, honors individuals who have made a contribution to the mission and ideals of the Clark School.

Margolis served as President of Energetics Incorporated in Columbia, Md. from 2010 until her retirement in the summer of 2017. During a 33-year long career at Energetics, Margolis supported clients at the U.S. Department of Energy (DOE) and its national laboratories on R&D programs to improve the energy efficiency of U.S. manufacturing. Before joining Energetics in 1984, she worked at ARINC Research Corporation and Bethlehem Steel Corporation. In addition to her M.S. in Mechanical Engineering, she holds a B.A. in Chemistry from Johns Hopkins University.

Margolis was recognized by DOE for her contributions to developing “Visions and Technology Roadmaps for U.S. Industries” and was also included by DOE on its “Steel Industry of the Future Wall of Fame.” She is a member of the American Society of Mechanical Engineers (ASME).

Margolis, who enjoys mentoring early- and mid-career women engineers, is also active here on campus. She currently serves as Chair of the Mechanical Engineering Visiting Committee.

Criteria for the Glenn L. Martin Medal include “truly exceptional service to their community, the Clark School, the profession, and/or the public; enhanced the student experience, research scholarship, academic excellence, technology commercialization, national and international reputation and impact of the Clark School; or someone who has managed or directed an organization that has made noteworthy national or international contributions in design, construction, production, or service delivery through the application of complex engineering principles.”

Margolis is the first mechanical engineering alumni recipient of the Glenn L. Martin Medal. She was presented with this honor at the 2017 Annual Recognition Dinner Celebrating Philanthropy, Service and Leadership held November 10th in A. James Clark Hall.

Alumni on Campus: **CAREER PATHS**

Fall 2017 CAREER PATHS	Spring 2018 CAREER PATHS
Weymouth Spence, BS ’08	Moniesha Jackson, BS ’96
Lee Barrett, BS ’80	Kevin Young BS ’93
Eric Jones, BS ’05	Semih Oktay MS ’84, PhD ’93
Kathy Eberwein, BS ’88	Sean Durbin BS ’93

Want to share your story?

CONTACT
mealumni@umd.edu

Hahn Receives NSF CAREER Award

The National Science Foundation (NSF) awarded Associate Professor Jin-Oh Hahn a 2018 Faculty Early Career Development (CAREER) Award for his project "Enabling 'White-Box' Autonomy in Medical Cyber-Physical Systems."

This award will support Hahn's research into autonomous healthcare (in particular, physiological closed-loop control), conducted in the Laboratory for Control and Information Systems.

With this funding, Hahn will develop tools and methodologies for medical cyber-physical systems (M-CPS) with the ultimate goal of improving autonomy in healthcare. He believes this research will advance the development and evaluation approaches for safe, efficacious and robust automation suited to healthcare applications.

In the past, autonomous medical systems were less successful as they could not be easily interpreted by the clinicians using them. Some of the reasons include: automation performed a specified task without considering the overall state of the patient; multiple automations that were not aligned to avoid conflicts; and that these autonomous systems were often prone to errors and failures.

Hahn's research aims to solve many of these problems. He will use this funding to develop methodological framework to build medical automations that can respond to a patient's current state of health in various circulatory resuscitation scenarios. Hahn will specifically investigate control-oriented mathematical modeling for a patient's physiological and pharmacological state in response to medication therapies, and coordinated and resilient multivariable closed-loop control based on such mathematical models. These models and algorithms will be "white-box," meaning they will be interpretable by clinicians.

Hahn will also leverage his close tie with the US Food and Drug Administration to investigate novel regulatory science methodologies for M-CPS and physiological closed-loop control systems. With these innovative tools and algorithms, Hahn's research may shape future M-CPS / physiological closed-loop control paradigms as well as create next-generation students and professionals equipped with M-CPS expertise.

"Prior autonomy capabilities in medicine have not been suitably mature for real-world critical care, due to the limitations in a few facets." says Hahn. "I intend to establish an integrated research, education, and outreach program to develop and demonstrate generalizable tools and methodologies for context-aware and interpretable "white-box" autonomy for coordinated, resilient physiological closed-loop control that can be easily supervised by human clinicians."

Radermacher Plenary Speaker at ASME IMECE

Minta Martin Professor of Mechanical Engineering and Director of the Center for Environmental Energy Engineering (CEEE) Reinhard Radermacher was a plenary speaker at the American Society of Mechanical Engineers (ASME) 2017 International Mechanical Engineering Conference & Exhibition. The conference is the largest interdisciplinary mechanical engineering conference in the world.

Radermacher delivered his talk "Thoughts on the Future of Energy in Buildings: An HVAC Perspective" for the Energy Track, discussing how increasing for energy efficiency drives buildings to become net-zero-energy facilities. His presentation summarized current approaches and outlined future developments and research needs for heating, ventilating and air-conditioning equipment, including a new generation of heat exchangers, heat pumping technologies and ventilation approaches.

Larsson Named Associate Editor of *AIAA Journal*

Mechanical Engineering Associate Professor Johan Larsson was named to the editorial board of the American Institute for Aeronautics and Astronautics (AIAA) Journal. He will serve in this role through the end of his term in 2020. The journal publishes papers on technical topics including aeroacoustics, aerodynamics, combustion and fluid mechanics, to name a few.

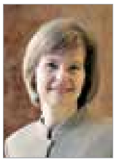
Larsson joined the Department of Mechanical Engineering in November 2012. He leads the Computational Turbulence Laboratory, which researches computational science, fluid mechanics, turbulence and turbulent combustion, high-fidelity simulations, and other related topics.

In his new role, Larsson joins Glenn L. Martin Institute Professor of Engineering and Affiliate Professor Elaine Oran of Mechanical Engineering at *AIAA Journal*, where she serves as a member of their advisory board.

AIAA Journal was established in 1963 and is published monthly.

Smela named Clark School Associate Dean for Faculty Affairs and Graduate Programs

Professor Elisabeth Smela (ME/ISR) was named Clark School Associate Dean for Faculty Affairs and Graduate Programs. A Professor of Mechanical Engineering, Smela has a joint appointment in the Institute for Systems Research and holds affiliate appointments in the Department of Electrical and Computer Engineering and the Department of Materials Science and Engineering.



Smela's research is primarily in the field of microelectromechanical systems (MEMS), particularly polymer MEMS and bioMEMS. She focuses on the use of organic materials (from polymers to cells) in microsystems to realize microactuators, cell-based sensors, and CMOS/MEMS integrated systems. She is internationally known for her work on microfabricated electroactive polymer actuators.

Smela earned a B.S. in physics from MIT and a Ph.D. in electrical engineering from the University of Pennsylvania.

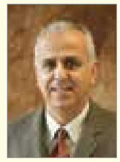
Prior to her arrival at UMD, Smela was a researcher at Risø National Lab in Denmark and helped start the company Santa Fe Science and Technology in New Mexico as Vice President of Research and Development.

In 2003, Smela won a National Science Foundation Faculty Early Career Development (CAREER) Award for her project titled, "Development of Advanced MEMS Actuator Technology for Microrobotics."

Smela also won the Presidential Early Career Award for Scientists and Engineers (PECASE) and the E. Robert Kent Junior Faculty Teaching Award. She has had a long-term interest in equity issues and has served on the University Senate Executive Committee and as an ADVANCE Professor. UMD's ADVANCE Program is focused on improving work environments, retention, and advancement of tenured and tenure-track women faculty in ways that improve the culture for all faculty.

Smela has published numerous journal articles, primarily on organic materials and microelectromechanical systems (MEMS). Her articles have appeared in a number of respected peer-reviewed journals, including *Science*, *NanoLetters*, and *Advanced Materials*.

FACULTY AWARDS AND RECOGNITION



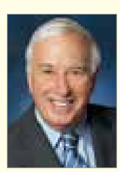
Professor **SHAPOUR AZARM** recently finished his tenure as Technical Editor of the American Society of Mechanical Engineers (ASME) *Journal of Mechanical Design*. He began his 5-year term in 2013.

Distinguished University Professor **AVRAM BAR-COHEN** has been elected as the inaugural president of the newly renamed Institute of Electrical and Electronics Engineers (IEEE) Electronic Packaging Society (EPS).

Two University of Maryland Department of Mechanical Engineering faculty members, Assistant Professor **SIDDHARTHA DAS** and Jeong H. Kim Professor **ABHIJIT DASGUPTA**, are part of new research team that recently received funding through a NextFlex award for their project "Conformal Printing of Conductor and Dielectric Materials on Complex 3-D Surfaces."

Assistant Professor **MARK FUGE** has been awarded a DARPA Young Faculty Award for a project entitled, "Topology and Synthesis of Design Manifolds," as part of the "Functional Mathematical Tools for Design" topic area. The grant builds upon past work in Design Manifolds by studying how multiple part manifolds interact in assemblies and how mathematical tools from topology, group theory, and machine learning can aid human exploration of large, complex design spaces. Fuge was also recently recognized with the Gemstone Mentor of the Year / Academy for Innovation and Entrepreneurship Faculty Fellowship.

Professor and Keystone Professor **BONGTAE HAN** was recently named an associate editor of *Microelectronics Reliability.* The journal publishes papers on the reliability of microelectronic devices, circuits and systems, from materials, process and manufacturing, to design, testing and operation.



C.D. (DAN) MOTE, Jr., President of the National Academy of Engineering and a Regents' Professor, former president of the University of Maryland and Glenn L. Martin Institute Professor of Mechanical Engineering has been named a Fellow in the National Academy of Inventors (NAI). Mote also delivered the Roy V. Wright Lecture. Established in 1949 in honor of Roy V. Wright, ASME's 50th president, the lecture is a way to impress on engineers and all young people, the duties, responsibilities and privileges of citizenship in our democracy.

ELAINE ORAN, Glenn L. Martin Institute professor of engineering at the A. James Clark School of Engineering, was one of two UMD faculty members elected to the 2018 class of the American Academy of Arts and Sciences, one of the nation's oldest and most reputable honorary societies.

Professor **MIAO YU**, Director of the Maryland Robotics Center, has been named an American Society of Mechanical Engineers Fellow. Yu currently serves as an Associate Editor for ASME's *Journal of Vibration and Acoustics*.

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