



2014

METRICS

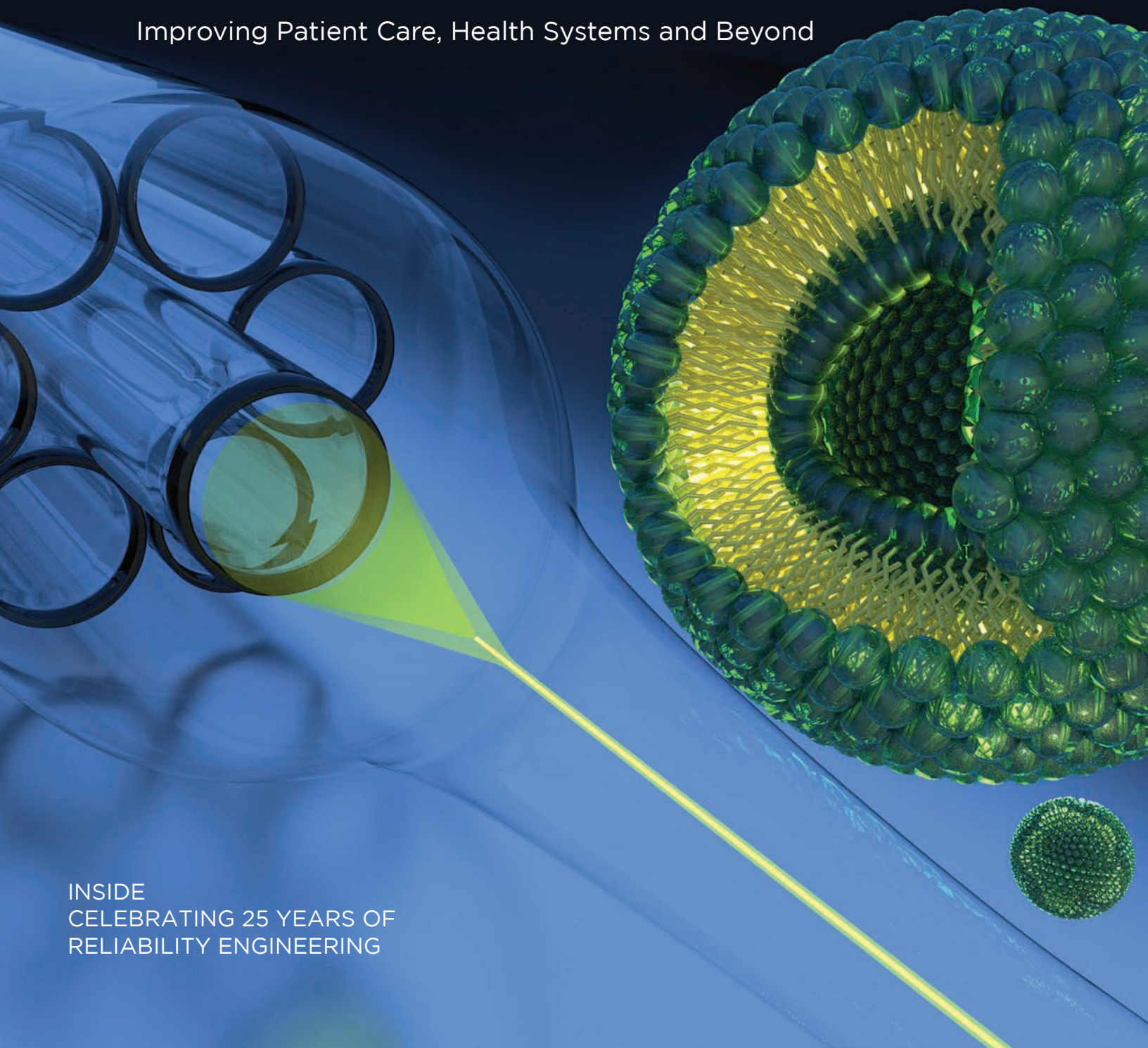
MECHANICAL ENGINEERING
A. JAMES CLARK SCHOOL *of* ENGINEERING

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MAKING MPACTS IN MECHANICAL ENGINEERING

Improving Patient Care, Health Systems and Beyond

INSIDE
CELEBRATING 25 YEARS OF
RELIABILITY ENGINEERING



chair's MESSAGE



B. BALACHANDRAN

Dear Friends,

It has been another landmark year for the Department of Mechanical Engineering at Maryland. Continuing with our long history of excellence in engineering education, the department's Center for Risk and Reliability celebrated its 25th anniversary of reliability engineering education and research. Twenty-five years ago, the University of Maryland (UMD) established the first degree-granting reliability engineering education program in the country, and today it is one of the largest and most comprehensive degree-granting graduate programs in the field of reliability and risk analysis

of engineered systems and processes. This year also marks 50 years since we awarded our first Ph.D. degree.

Supporting the Evolution of Mechanical Engineering

Mechanical engineering continues to be an ever-evolving discipline, and as we look to the future, we see a greater collective impact from our work in engineering across people's lives, and across the globe. Engineering is becoming more inter-disciplinary, and as you will see in this issue's research highlights, we are making impacts across fields ranging from robotics to health and health care systems, risk and reliability engineering to energy systems, and sustainable energy and infrastructure to electronics and manufacturing. Together, our faculty, researchers and students are addressing challenging issues in brain injury mechanics, health care diagnostics and patient care, energy efficiency, energy storage, electronics and even bee health.

We continue to enhance the learning experience for our students through expanded education programs, experiential and hands-on learning, unique research opportunities and top-notch academics.

Faculty and Staff Notables

Over the past year, our faculty members were recognized for their outstanding research, academic work and achievements. President Barack Obama named Associate Professor Sarah Bergbreiter a recipient of the Presidential Early Career Award for Scientists and Engineers, an honor previously received by only three other faculty members at the university. The University of Maryland recognized George E. Dieter Professor Michael Pecht, director of the Center

for Life Cycle Engineering (CALCE) with the university's inaugural Corporate Connector Award for his role in engaging the private sector and making CALCE the world's largest consortium in electronic parts reliability engineering, accelerated testing and supply chain management. Professor Avram Bar-Cohen received both the American Society of Mechanical Engineer's (ASME) 75th Anniversary Medal and the 2014 Institute of Electrical and Electronics Engineers (IEEE) Components, Packaging and Manufacturing Technology Award. Some additional honors include: Professor James Duncan was awarded a two-year Wilson Elkins Professorship by the University System of Maryland (USM); Professor Michael Ohadi received a 2014 USM Regents' Faculty Award for Excellence in Innovation; Professor Peter Sandborn was elected both an ASME and IEEE Fellow; Associate Dean and Keystone Professor William Fournery received the 2014 M.M. Frocht Award from the Society for Experimental Mechanics; Assistant Professor Jin-Oh Hahn won both the Korean-American Scientists and Engineers Association Young Investigator Grant and a Young Investigator Program (YIP) Award from the U.S. Office of Naval Research; and Professors Amr Baz and Jungho Kim have been named Keystone Professors.

The University of Maryland also recognized staff from both our undergraduate and graduate offices for their outstanding contributions to both our students and the department. Amarildo DaMata, coordinator of graduate studies, received a 2013 Outstanding Coordinator of Graduate Studies Award, and Assistant Director of Undergraduate Studies Terry Island received UMD's 2012-2013 Academic Advisor of the Year Award.

As we look to the next year, we would like to thank all of our alumni, friends and corporate partners who have contributed to the success and development of the department. With such generous support, we are able to provide further resources for our faculty and students to enrich their research and academic endeavors. We welcome our friends and alumni to reconnect with us and join our efforts to educate and inspire the next generation of multidisciplinary engineers.

B. Balachandran

Balakumar Balachandran
Chair and Minta Martin Professor

Chair Balachandran (second from right), with Terps Racing's Emily Posey, undergraduate in mechanical engineering (left), Mechanical Engineering Visiting Committee Member T.G. Marsden, vice president, Automotive Products, Bowles Fluidics Corp. (second from left) and University of Maryland President Wallace Loh (right) at event celebrating Siemens Corporation's software grant donation of Siemens PLM Software (valued at \$750 million), a sophisticated design and simulation tool for course work, research, academic projects and team-based competitions.





THE TERPS RACING TEAM UNVEILS THEIR 2014 SAE FORMULA ONE CAR, TR14, AT MARYLAND DAY, APRIL 26, 2014.

METRICS

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SPRING 2014

ON THE COVER

Graphic rendering of a new facile route to synthesize monodisperse nanoscale liposomes.

IMAGE CREDIT

Javier Atencia, Research Professor
University of Maryland
Bioengineering Department

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ON THE WEB AT

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Making Mpacts in Mechanical Engineering

Mechanical engineering may be one of the oldest disciplines in engineering, but Clark School researchers are using the latest technologies to create novel engineering solutions throughout the department. Their work is making a significant impact in traditional industries and the highly dynamic areas of healthcare and energy.

Emergency Preparedness, Patient Care and Tackling Medical Challenges

When you think of treating chronic diseases or creating revolutionary medical devices, mechanical engineering might not be the first field to come to mind. Think again. Researchers are applying basic and advanced mechanical engineering principles to improve emergency preparedness efforts, help patients better manage their own care and address one of today's most complex medical challenges—the prevention and treatment of traumatic brain injury.

Although the opportunities to reduce the likelihood of a terrorist attack are limited, steps can be taken to reduce the consequences. Associate Professor Jeffrey Herrmann is drawing on his background in operations research and industrial engineering to improve emergency planning. “Some years ago, we began a collaboration with Montgomery County, Maryland, to develop mathematical models that could be used by emergency preparedness planners to design points of dispensing (POD) for distributing medications or vaccinations during a public health emergency, such as an outbreak of smallpox or anthrax,” says Herrmann. His models were based on queuing theory, and the software he developed has been used by public health agencies nationwide. “In the H1N1 flu epidemic a few years ago, this software was useful in planning the vaccination clinics,” relates Herrmann, who has presented his research before the Institute of Medicine on issues surrounding the “stockpiling” of antibiotics by agencies and individuals.

Herrmann is now collaborating with UMD Marketing Professor William Rand to analyze Twitter data collected during Superstorm Sandy and Hurricane Irene as part of a study on the diffusion of information during emergencies. “If we can predict how fast people react to information, then we can better predict demand for vaccinations and medications,” adds Herrmann.

For individuals who suffer from chronic diseases such as diabetes and frequently must administer their own medication and monitor their conditions, Professor Monifa Vaughn-Cooke is exploring design options to make the required medical devices easier to use. “Many devices, such as glucose meters (glucometers) and blood pressure monitors, are designed without thinking of the end users, who often have vision, mobility and other impairments and are often part of high-risk demographic subgroups,” says Vaughn-Cooke, who recently testified at a U.S. Food and Drug Administration (FDA) hearing on the importance of including such groups in usability testing for medical devices.

In work funded by the Maryland Center for Excellence in Regulatory Science and Innovation and the FDA, Vaughn-Cooke is drawing on her expertise in human factors engineering to determine how data taken by diabetic patients through blood pressure monitors and glucometers could be directly integrated into their personal health records. “If we can integrate biometric information and reduce the collection of data to one device, we could help patients better adhere to doctor's orders,” she adds.

Her work with students was recognized with a first place win in the 2013 American Public Health Association's (APHA) Codeathon, a student competition for projects that could assist in the implementation of the Affordable Care Act (ACA). The UMD team's winning entry was ACA Benefits Buddy, an easy-to-use application that connects users with basic information on preventative health benefits.



FROM LEFT TO RIGHT: UMD TEAM MEMBERS AND GRADUATE STUDENTS LUIS SANTOS AND MAIA NAFTALI, STEPHEN CLARKE, MARION COUNTY HEALTH DEPARTMENT AND CHRIS GUDAS, JOHNS HOPKINS UNIVERSITY.



Improving Blood Pressure Diagnostic Tools and Drug Delivery Systems for Critical Care Patients

Blood pressure measurements are an important indicator of an individual's cardiovascular health; however, most traditional blood pressure assessment tools do not always provide accurate or reliable readings. Assistant Professor Dr. Jin-Oh Hahn, an expert in biosystems and healthcare, is tackling two projects to improve non-invasive, blood pressure diagnostic capabilities.

Hahn is working on one project that aims to improve the accuracy of existing blood pressure tools, like the blood pressure cuff in your doctor's office, by creating algorithms that will improve blood pressure readings by using aortic blood pressure (BP).

Pressure readings taken closer to the heart, aortic BP and flow, rather than BP taken on the arm, provide a better picture of a patient's cardiovascular health. Currently, aortic BP measurements with a high degree of accuracy can only be taken through invasive aortic catheterization. Hahn's work uses aortic BP data to create algorithms that will improve readings taken peripherally on the arm and provide a more accurate estimate of a patient's cardiovascular health.

This improved signal-processing algorithm could be implemented into existing blood pressure tools and monitors—much like a software update—without the need to completely re-design the blood pressure tool itself, providing an easier and more cost effective healthcare upgrade to implement.

With over a quarter of the U.S. population suffering from some form of cardiovascular disease, Hahn's vision is to extend his blood pressure work into improved screening tools for cardiovascular disease.

Hahn's second project is to develop a cuffless blood pressure diagnostic model that would use pulse wave velocity—the time it takes blood to travel from the heart out through the arterial tree. This research could lead to a compact alternative to the BP cuff and provide a low-cost, high throughput and continuous blood pressure monitoring tool for independent healthy living.

Hahn is also working with Assistant Professor of Surgery Andrew Reisner in the Department of Emergency Medicine at Massachusetts General Hospital to improve drug delivery systems for patients. Individual responses to medications are highly variable. These responses can be subtle, yet highly detrimental to the patient if they are not quickly noticed and accounted for in the administration of the drug. Hahn and Reisner are working to develop a better system for drug administration that would use a patient's biofeedback information, such as blood pressure, respiration and pulse, to

(continued on page 4)

Robots to the Rescue

In the not-so-distant future, a different type of technology – robots – may play an even greater role in patient care. “To take robots to the next level in patient care, they need to respond to touch and physically communicate in ways similar to human touch interactions,” explains Professor Elisabeth Smela. Together with Professor Hugh Bruck and Associate Professor Miao Yu, Smela is now working on a project to develop sensory abilities in robots, which will allow them to better respond to patient needs such as moving them in and out of bed.

Through “Compliant Multifunctional Robotic Structures for Safety and Communication by Touch,” a three-year, \$600,000 NSF-funded grant that is part of the National Robotics Initiative, they will develop a sensory system for robots similar to the human nervous system using deformation sensitive polymers. The sensing skin will be integrated onto compliant, padded robot structures and will be able to detect the distribution of applied forces. It will contribute to new bio-inspired control principles for training robots. “If robots can distinguish humans from other objects in their environment, it will significantly advance robotic safety and decision-making and create possibilities for new multifunctional robots in critical fields such as healthcare,” adds Yu, who has obtained three patents in the area of fiber optic sensors. Her work has been recognized with an NSF Faculty Early Career Development (CAREER) Award and a Young Investigator Research Program Award from the Air Force Office of Scientific Research. She was previously recognized by the UMD Office of Technology Commercialization for developing a fly ear-inspired miniature acoustic sensor system that mimicked a fly's highly accurate directional hearing.

Associate Professor Sarah Bergbreiter, Mechanical Engineering and Institute for Systems Research, along with Associate Professor Teng Li, is also receiving funding as part of the National Robotics Initiative. Her work on “Active Skins for Simplified Tactile Feedback in Robotics” was among eight robotics projects funded by NASA to support future missions in space. Her focus is on the fabrication process, modeling and algorithm design for sensors that will allow robots to more easily acquire and interpret tactile data. ■

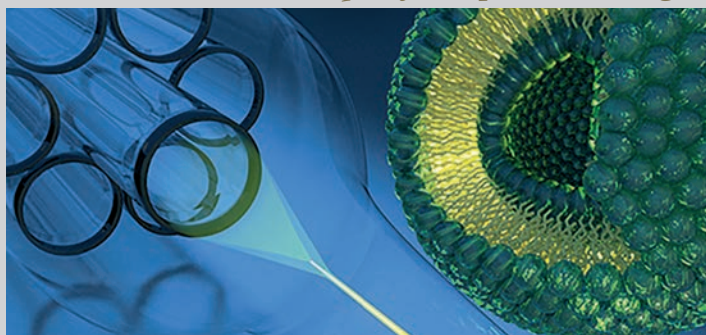


Learn more about Bergbreiter's NSF funded robotics research.

automatically adjust the drug delivery based on those changes, which is important for patients in critical care.

In particular, Hahn is looking at vasopressors, drugs used to raise blood pressure in patients with poor circulation, such as those with spinal cord injuries or extreme low blood pressure. He has created a new analytic tool to improve the administration of vasopressors by using changes in blood pressure to evaluate underlying cardiovascular factors to automatically adjust drug administration. This could lead to automated control of vasopressor therapy and improved patient care outcomes.

New Fabrication Techniques for Liposomal Drugs



A NEW FACILE ROUTE TO SYNTHESIZE MONODISPERSE NANOSCALE LIPOSOMES. CREDIT: JAVIER ATENCIA, RESEARCH PROFESSOR, UMD

Liposomal drugs are a critical piece in treating a wide range of cancers. Liposomes are tiny, versatile nanoscale capsules that can deliver high concentrations of drugs in very selective ways, and reduces the degree of toxicity when compared to delivering the drug alone. They are particularly effective in cancer drugs and treatments because they are biocompatible and can be used to deliver drugs directly to cancerous tumors and other diseased cells or tissue.

Currently, liposomal drug production involves complex, multi-stage processes that take almost a week to complete. The complexity of the process has resulted in poor drug reliability and frequent drug shortages. In recent years, highly effective liposomal cancer drugs, such as Doxil®, were forced off the market due to issues in manufacturing reliability and the high cost of production. These drug shortages adversely affect cancer patients—causing further spread of their disease, to experience relapses or develop complications from changes in their drug treatments.

Professor Don DeVoe, along with Renee Hood (Bioengineering, Ph.D. '14) and collaborators Javier Atencia, Wyatt Vreeland and Donna Omiatsek at the National Institute of Standards and Technology, has developed a new and more reliable system for synthesizing liposomes that could reduce the time it takes to produce critical drugs and increase the reliability of the product.

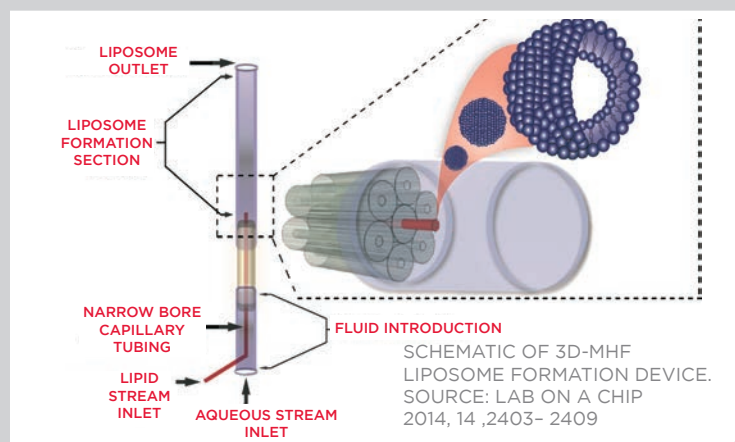
The team's new liposome generator is a 3D microfluidic

device that consists of a 3-millimeter-diameter glass cylinder containing a bundle of seven tiny glass capillary tubes—each about the diameter of a pinhead—with one in the center and six surrounding it. A microsized plastic capillary (about 500 micrometers in diameter or the length of an amoeba) is fed through the center tube and extended just beyond the end of the capillary bundle. A water-based solution (known as PBS) flows through the outer six capillaries while the center channel carries the phospholipid dissolved in alcohol (in production, the PBS would carry a drug or other cargo for the vesicles). A standard glass pipette attached to the end of the microfluidic device improves mixing by concentrating the ratio of water to lipid/alcohol.

“The capillary-based device in this study overcomes multiple shortcomings of bulk-scale production, including size variability and process reliability, while reducing production costs. This is significant because size and size variability are imperative factors for drug delivery and dosing,” Hood says. “The 3D microfluidic device we have developed generates distinctly-sized liposomes at a rate which is four orders of magnitude faster than previous 2D devices and can be assembled from commercially available materials which require no expensive laboratory infrastructure or equipment.”

“When combined with other microfluidic technologies developed by our team, this system can generate the next generation cancer-targeting liposomal drugs in only 15 minutes using a single chip, unlike conventional methods that require a week using multiple reaction vessels,” says DeVoe, who directs the Maryland MEMS and Microfluidics Lab.

The team's device will improve the liposomal nanomedicine manufacturing process by enabling precise control over nanoparticle size, decreasing production time and improving reliability. This would increase the availability of critical cancer drugs while enabling the development of a new class of size-optimized liposomal drugs and greatly improve patient care and outcomes.

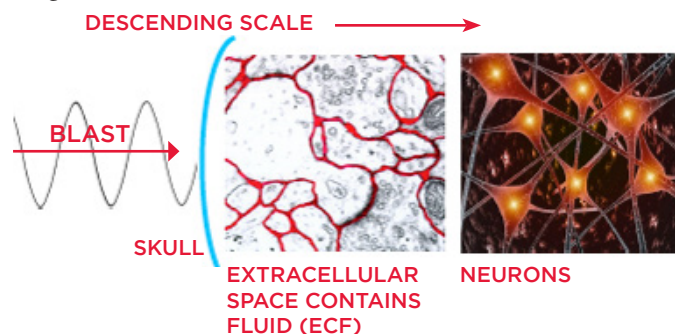


SCHEMATIC OF 3D-MHF LIPOSOME FORMATION DEVICE. SOURCE: LAB ON A CHIP 2014, 14, 2403–2409

An Engineering Approach to Traumatic Brain Injury Research

While the medical profession focuses largely on biochemical changes to the brain during traumatic brain injury (TBI), Associate Research Professor Henry Haslach and colleagues are looking at mechanical processes that could be precursors to those biochemical changes.

In work published in the *Journal of the Mechanical Behavior of Biomedical Materials*, Haslach and his team describe how the brain is made up of both solid matter and a high fluid content, and the configuration of “brain tissue is maintained by the interaction between the cellular solid material and the brain extracellular fluid (ECF).” Their research suggests “trauma-induced increases in ECF hydrostatic pressure, which may induce pathological ECF flow, are a possible immediate mechanical cause of brain damage.”



By comparing organs and tissues such as cartilage and arterial tissue that are load-bearing with the brain that is not load-bearing, Haslach hopes to gain more insight on how brain injury occurs. “We are focusing on substructures in the aorta to develop a rupture theory for arteries,” adds Haslach, because the widely accepted fracture theory for metals does not apply to hydrated biological soft tissue. The researchers are working to develop a mathematical model to help predict brain response to impact, particularly to blast injuries sustained in military combat.

Professor Ken Kiger, along with Clark School benefactor and entrepreneur Robert E. Fischell, M.S. '53, physics, is developing a new device to prevent traumatic brain injury for athletes. Their company, Guardian Helmets, LLC, was founded to accelerate the development of a device that uses “smart fluids” to resist impact to the head much like shock absorbers help a car deflect bumps in the road.

“Dr. Fischell’s idea was to design a damper that connects the helmet and body and absorbs impact on the playing field,” explains Kiger. The device, called a Superspine, would be made of high-strength metal plates attaching to the back of a helmet and to the top of the shoulder pad. “The

innovative part of the design is the use of a shear thickening fluid suspension inside the plates, which would allow for a full range of motion under normal conditions while stiffening to a nearly rigid connection between the head and body during impact,” says Kiger. “This design concept could dramatically reduce the occurrence of concussions of the brain without restraining head motions.” Initial testing results have been encouraging, and the team will be refining the prototype in the months to come.

Kiger and Fischell have applied for a patent for the device and have submitted a proposal for additional funding to the National Football League and GE-sponsored Head Health Challenge, which supports projects designed to improve the safety of athletes and military members.

Building an Energy-efficient and Resilient Future

With national and regional renewable energy goals in mind, researchers are pursuing a host of initiatives to reduce energy consumption and create viable energy alternatives. “Because the footprint of mechanical engineering decisions is seen on a global scale, we are working more closely with meteorologists, climate scientists, social scientists and policymakers to make a difference,” explains Professor Jelena Srebric, who is an Elected International Fellow of the Serbian National Academy of Engineering. Her recent work has focused on analyzing and reducing energy consumption in the building environment.

In a four-year study funded by the NSF, Srebric and colleagues assessed the interaction between building design and energy management on the campuses of Harvard University, Massachusetts Institute of Technology and Pennsylvania State University. “Our findings demonstrated the difficulty of collecting good data on building energy performance,” says Srebric, who noted that information, such as peak use and energy demands by various tenants in multi-use buildings, is difficult to track. This year, she is working with students to collect, analyze and compare data for different buildings on the UMD campus.

Another research proposal currently under review, “Community Infrastructure for Transformation of Urban Ecosystems through Anticipatory and Adaptive Energy-Population Interactions (CITY-EN),” would pair Srebric with colleagues on multidisciplinary teams to study urban energy consumption in four East Coast cities: Boston, New York, Philadelphia and Washington, D.C. “We will look at the socioeconomic, public health, climate, policy, and building energy and power system aspects of the urban energy sustainability challenge,” explains Srebric, who is leading the department’s efforts to create a graduate certificate and a new master’s degree in sustainability. *(continued on page 6)*

Residential and commercial buildings now account for nearly 40 percent of total U.S. energy consumption. The energy-saving imperative is clear: Create heating and cooling products for buildings that use less energy. For two consecutive years, student teams, led by Research Professor Yunho Hwang, have garnered top honors in a national competition to design, build and test ultra-efficient product prototypes that can reduce energy consumption in buildings.

Last year, the winning team created an energy-saving, two-stage heat pump clothes dryer. The team's heat pump dryer could improve energy savings 40 to 46 percent over the average U.S. electric dryer. In 2012, a UMD team developed a super energy-efficient air conditioner. Conventional air conditioning systems use the same process to cool and remove moisture from indoor air – typically cooling air below the desired temperature to remove humidity and then reheating it. The UMD team designed a wall unit that separates the two processes, creating a separate system for both sensible and latent heat cooling. Tests of the prototype in a climate chamber showed energy savings of more than 30 percent over standard air conditioners.

At UMD's Center for Environmental Energy Engineering, where he directs the Alternative Cooling Technologies and



ME STUDENTS WORK ON ENERGY-SAVING, TWO-STAGE HEAT PUMP CLOTHES DRYER FOR MAXTECH COMPETITION.

Application Consortium, Hwang works with some 30 research sponsors, including the U.S. Department of Energy, U.S. Department of Defense and the Maryland Industrial Partnerships Program to improve energy efficiencies. His most recent work moves beyond using vapor compression to meet cooling and refrigeration needs to neutralizing shape memory alloys and using them as an active material for elastocaloric cooling, a solid state cooling mechanism.

When it comes to energy-saving transportation, one of the most technically challenging barriers to the widespread commercialization of hydrogen-fueled vehicles is the limitation of on-board hydrogen storage. Associate Professor Teng Li is working with the world's thinnest material –

graphene – as a solution for more efficient hydrogen storage.

Li, a Keystone professor and member of the Maryland NanoCenter and the university's Energy Research Center, and Graduate Student Shuze Zhu have found that they can make one-atom thick squares of graphene fold into a tiny origami box, which will open and close itself in response to an electric charge. Inside the box, the team stored hydrogen atoms more efficiently than previously thought possible, reaching storage density of 9.5 percent hydrogen by weight. "We believe we can reach even higher storage density," says Li, noting the project has already exceeded the 7.5 percent hydrogen weight goal set by the U.S. Department of Energy for 2020. The technique could greatly increase a fuel cell's ability to store and release hydrogen—an advance that could improve the capacity of hydrogen fuel cells for powering cars. Li is also part of a research team that developed a battery made of wood fibers that could advance the development of long-lasting, sodium-ion batteries, a promising solution to low-cost and high-performance, grid-scale energy storage.



HYDROGEN (WHITE) IS PACKED INTO A TINY BOX MADE OF GRAPHENE, WHICH RESEARCHERS AT THE UNIVERSITY OF MARYLAND CAN OPEN AND CLOSE USING ELECTRICITY. CREDIT: MARYLAND NANOCENTER

Professor F. Patrick McCluskey is studying another source of alternative energy—offshore wind turbines—in collaboration with Aris Christou, a professor in the Departments of Mechanical Engineering and Materials Science and Engineering. The team is analyzing data collected from wind turbine projects in the North Sea to make recommendations on the installation and servicing of turbines as part of the Maryland Offshore Wind Energy Research (MOWER) Challenge Program.

"Studies show that electronics cause more than half of all unscheduled maintenance in wind turbines," says McCluskey. "The turbines are exposed to large crashing waves, storms, high winds, sun and ultra-violet radiation. If we can make electronics robust against the offshore environment and reduce repairs, we can help make wind turbines economically viable as the state starts to build offshore wind turbine fields in the Atlantic Ocean." McCluskey's latest research stems from more than 20 years of experience working with power electronics for such applications as down-hole, oil well drilling, hybrid vehicles and industrial motor drives, much of which has been conducted through the Clark School's Center for Advanced Life Cycle Engineering. ■

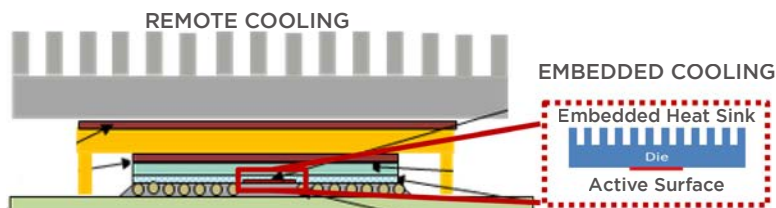
Embedded Cooling Could Advance Next Generation Power Electronics

Professor Michael Ohadi is leading a \$2.1 million contract from the Defense Advanced Research Projects Agency (DARPA) to develop “embedded cooling” technology for compound semiconductor microchips and high power electronic systems.

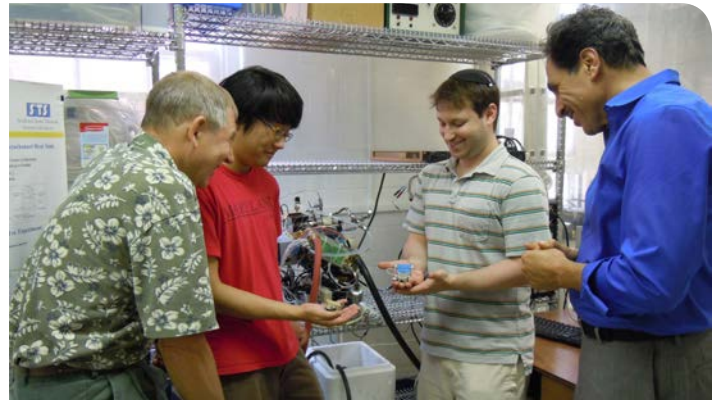
Inadequate cooling capabilities for on-chip computing power has constrained advances in high-performance electronic systems in both commercial and defense applications. DARPA’s IntraChip Enhanced Cooling (ICECool) program, which funds the contract, is seeking to integrate a thermal management solution directly into the chip layout. The UMD team will use innovative microfluidics and on-chip thermoelectric coolers to improve chip cooling rates, reduce the size of the cooling package and decrease the amount of cooling fluid in circulation.

The Maryland team, which also consists of Professors Serguei Dessiatoun, F. Patrick McCluskey and Bao Yang, will develop a system in which a thin film of fluid is pumped through a series of channels, narrower than the width of a human hair, etched onto the chip’s substrate. As the fluid evaporates in a thin film mode, it cools the chip in the same way the human body uses perspiration for evaporative cooling. When successfully implemented, thin film evaporation can be one of the most effective cooling mechanisms, with potential for at least an order of magnitude higher cooling rates than most conventional cooling technologies.

“With a direct or embedded cooling system, it is possible to achieve high levels of cooling while shrinking the dimensions of the thermal management hardware, since the embedded microfluidic-based system will deliver the cooling in close proximity to the on-chip heat source,” says Ohadi, principal investigator for the project. “We are at the frontier of the specific technology area for each of the topics we are pursuing, which requires pushing the envelope into uncharted territories.”



SOURCE: AVRAM BAR-COHEN “GEN-3 THERMAL MANAGEMENT TECHNOLOGY: ROLE OF MICROCHANNELS AND NANOSTRUCTURES IN AN EMBEDDED COOLING PARADIGM,” JOURNAL OF NANOTECHNOLOGY IN ENGINEERING AND MEDICINE, 2013.



FROM LEFT, RESEARCH SCIENTISTS AND CO-PRINCIPAL INVESTIGATOR (PI) SERGUEI DESSIATOUN, RESEARCH ASSISTANT DANIEL BAE, RESEARCH ASSISTANT AND PH.D. CANDIDATE RAPHAEL MANDEL, AND PROFESSOR AND PI MICHAEL OHADI

Some of the major challenges the team faces are designing for material and fabrication constraints, selecting a working fluid that is compatible with the intended application, avoiding local dryout, raising the critical heat flux and ensuring that the system performs reliably under harsh conditions and repeated on-off cycles.

Maryland leads a team that includes Case Western University, Laird Technologies (formerly Nextreme Thermal Solutions), Boeing Space and Intelligence Systems and Science Research Laboratory in the three-year research program. The collaboration will help ensure that the proposed solutions are compatible with defense system requirements.

The ICECool proposal grew out of more than 25 years of research at the cutting edge of thermal packaging technology, with significant funding from industry and government agencies. These efforts were considerably strengthened by Professor Avram Bar-Cohen, former chair of the department who is internationally recognized for his pioneering text books and recently released Encyclopedia of Thermal Packaging. Reflecting the growing need for innovative thermal management techniques, the UMD team is establishing the Maryland Center for Embedded Cooling (MECo) to pursue direct cooling in a diverse range of thermal management applications. MECo researchers look to directly impact high-performance computing, power electronics, renewable energy and smart grid development, energy recovery/conversion, and process intensification applications. ■

Shaking Things Up!

Students Help Biologists Build Innovative Solution to Save Honey Bees



FROM LEFT, ENGINEERING STUDENTS MAX FRANTZ, JAKE JOHNSON, MARK RAGLAND AND SEAN BARTLETT, CHANG-SEI KIM (MECHANICAL ENGINEERING), ANDREW GARAVITO (UMD ENTOMOLOGY LAB) AND MEGHAN MCCONNELL (UMD ENTOMOLOGY LAB)

Clark School engineering students are leveraging their know-how to help bee biologists develop a non-chemical, mechanical solution to one of the toughest problems facing honey bee populations. As part of a cross-department collaboration between the UMD Department of Entomology and the Department of Mechanical Engineering, students, researchers and faculty are developing a device that could help reduce the number of parasitic varroa mites currently infesting honey bee colonies.

According to honey bee expert and UMD Associate Professor Dennis vanEngelsdorp, varroa mites are one of the leading causes of mortality for European honey bees and the number one issue challenging bee keepers. Varroa mites, sometimes referred to as vampire mites, are ectoparasites that feed off the blood of both adult and juvenile bees, weakening their immune systems and making them susceptible to viruses and infection. The parasites are becoming resistant to chemical treatments, and more effective treatments cannot be used when bees are producing honey for human consumption.

Over the years, vanEngelsdorp noticed that hive disturbances—such as hive relocation or transport in a vehicle—often led to a decrease of varroa mite infestation on bees in a hive. The disturbances seemed to generate enough vibration to cause the mites to fall off their hosts. These observations made vanEngelsdorp wonder if he could create a non-chemical, mechanical solution to this problem—a hive mounted ‘Bee Shaker’ that could create

enough vibration to force mites off host bees without physically moving hives. VanEngelsdorp also serves as a project director for the Bee Informed Partnership, a collaborative effort between research institutions, universities and beekeepers, funded by the U.S. Department of Agriculture and the National Institute of Food and Agriculture, to accelerate the flow of information among beekeepers. He was prompted by the partnership’s project manager and engineer, Karen Rennich, to seek help from the UMD’s Department of Mechanical Engineering.

A team of faculty and undergraduate students pursued the project as part of a class aimed at tackling “advanced

problems in mechanical engineering.” Led by Assistant Professor Jin-Oh Hahn, the Bee Shaker team included post-doctoral research fellow Chang-Sei Kim and undergraduate students Max Frantz, Jake Johnson, Mark Ragland, Sean Bartlett, Pedro Pessoa and Matthew Lewis. The students dove into the design challenge, brainstorming ideas and selecting and discarding components to develop the Bee Shaker prototype.

Johnson, a senior in mechanical engineering, enrolled in the course because he was looking for more hands-on experience. While the team initially spent a large chunk of time pouring through data sheets to find the right parts for the project, he “had a taste for a large design project” and enjoyed the creative freedom the project offered.

The student team applied principles of control systems engineering—the same principles that apply to automobile traction and cruise control systems—to develop a successful Bee Shaker prototype that was capable of producing vibrations at variable speeds, forces and frequencies. The students designed a computer-controlled and programmed shaker to be mounted to the side of hives so beekeepers and researchers could test a variety of scenarios on the hives.

Students refined the prototype design this spring by making it smaller, more powerful and capable of running off a portable energy source such as a car battery. The current team,

Johnson, Lewis and Pessoa, also standardized the prototype production process by designing a unit that could be constructed from parts that could be manufactured on a 3-D printer. Based on the team's success with its designs and fabrication process, vanEngelsdorp is testing several prototypes on colonies to determine their effectiveness on varroa mite infestation.

Collaborations like the Bee Shaker project are part of an ongoing effort to create multi-disciplinary design courses for engineering students. These projects not only assist researchers attempting to solve critical issues, but create unique learning opportunities for students. ■



“Such projects...allow students to exercise their design and analysis skills on an open-ended and realistic project, which is often difficult to squeeze into a classroom environment.[Students] also get practice articulating ideas to different audiences, which is an important skill in their future professions.”

**Mechanical Engineering Director of Undergraduate Studies
Kenneth Kiger**

Solar Energy Helps Power Robo Raven III

As Robo Raven III navigates the skies, it could be drawing more and more of its energy from the sun. Professors S.K. Gupta, (Mechanical Engineering and the Institute for Systems Research) and Professor Hugh Bruck and their students in the Maryland Robotics Center have developed and demonstrated a new version of the Robo Raven micro air vehicle (MAV) that incorporates solar panels in its wings.

While the solar panels do not produce enough energy to power Robo Raven III in flight (they produce around 3.6 watts while Robo Raven needs around 30 watts to fly), they are effective in charging the MAV's batteries when it is stationary.

Because the vehicle's wings offer a surface area that is large enough to create a usable amount of solar energy, the Robo Raven team decided to incorporate flexible solar cells into them. The captured solar energy is then used to supply Robo Raven's onboard batteries. “These new multi-functional wings will shape the future of robotic birds by enabling them to fly longer, farther and more independently because they will be getting their power from the sun,” says Ph.D. student Luke Roberts, a member of the Robo Raven team.

The underlying material of the flexible solar panels required that the team design new wings and develop a new additive manufacturing process to fabricate them, Gupta says. “We still need to make significant improvements in solar cell efficiency and battery energy density to replicate the endurance of real ravens in Robo Raven III,” Gupta notes, “but the good news is that Robo Raven III has already demonstrated it can fly with a solar cell and battery combination. Now that we've successfully taken this step, swapping new, more efficient technologies should be relatively simple.”

Gupta has been working on flapping-wing robotic birds for the better part of a decade. His team first successfully demonstrated a flapping-wing bird in 2007. In spring 2014, the group introduced Robo Raven, the first flapping-wing MAV with independently flapping, programmable wings. ■



ROBO RAVEN III IS THE FIRST FLAPPING WING MAV IN THE WORLD THAT FLIES ON BATTERIES CHARGED BY ONBOARD SOLAR CELLS.



UMD Celebrates 25 Years of Excellence in Reliability Engineering

On April 2, 2014, the Center for Risk and Reliability hosted a 25th Anniversary Celebration of the University of Maryland's Reliability Engineering Education Program. From energy, defense and infrastructure to manufacturing, systems and software, reliability engineering is an integral and fundamental part of ensuring that today's complex technological systems operate safely and efficiently.

UMD was the first university in the U.S. to establish a degree-granting program in reliability engineering, and it continues to be one of the flagship programs in the field.

Over 120 reliability engineering experts, leaders and alumni attended the event, which kicked off with a symposium featuring presentations from members of NASA, the U.S. Nuclear Regulatory Commission (NRC), Constellation Energy Nuclear Group, Northrop Grumman and the Ford Motor Group. In addition to federal agency and industry representatives, speakers included a host of faculty and researchers from both UMD and universities across the U.S. and abroad.

A series of panelists spoke to the impacts and value of reliability engineering across a variety of disciplines—from nuclear energy to the automotive and defense industries—and presented areas for future research and exploration.

NRC Commissioner George Apostolakis and Chief Nuclear Officer for Constellation Energy Group Maria Korsnick discussed the critical importance of risk assessment and reliability engineering in nuclear energy for improving safety and mitigating both internal and external risks.

NASA Deputy Chief for Safety and Mission Assurance Thomas Whitmeyer provided insights into NASA's Mars missions and the impact of reliability engineering for successful space missions. Northrop Grumman Engineering Fellow Elias Anagnostou discussed the impacts risk assessment had on deploying new technologies in fixed-wing plane fleets. He highlighted the Defense Advanced Research

Projects Agency (DARPA) and the Navy's Structural Integrity Prognosis System (SIPS) that was used to manage uncertainty and provide actionable information that helped reduce the costs associated with failures.

University of Tennessee Postelle Professor and Head of Nuclear Engineering J. Wesley Pines and Rutgers University Distinguished Professor Haong Pham presented the challenges currently confronting educators in reliability engineering and highlighted both educational opportunities and hurdles facing today's reliability engineering students.

Featured keynote speakers included UMD Reliability Engineering Kenneth Farquhar (M.S. '93), president and general manager of ManTech International Systems Engineering and Mission Support Business Unit, and Jeong H. Kim, entrepreneur, chairman of Kiswe Mobile and former president of Bell Labs. Kim was the first recipient of a Ph.D. from Maryland's Reliability Engineering Program, and he discussed the vision and impact of reliability engineering for both the center and himself.

"At first, my thought was that [reliability engineering] was an offshoot from the nuclear engineering program—where risk assessment was a component of it—but obviously with broader implications.

I quickly realized that the vision for reliability engineering was much, much broader," said Kim. "The vision is that you are dealing with uncertainty. Which happens in industry, it happens in your personal life, it happens all over the world. How to deal with uncertainty and incorporate that into your decision making process was the skill set that I acquired that has served me well over all of these years." ■

"There have always been reliability engineers because risk-assessment is so fundamental to so many fields, but the development of reliability engineering as a formal educational program—that is what is so significant. And it is not just that they helped birth a new discipline and educated the next generation, but it is also that so many of you who are here today...helped contribute to the development of this discipline."

- UMD President
Wallace Loh

Presentations and speaker videos available at:
ter.ps/re14website



SYMPOSIUM PARTICIPANTS HAD THE OPPORTUNITY TO ENGAGE WITH SPEAKERS THROUGH Q & A SESSIONS.



JEONG H. KIM & MARVIN ROUSH



KENNETH FARQUHAR



ALI MOSLEH WELCOMING SYMPOSIUM PARTICIPANTS



JEONG H. KIM



ALI MOSLEH AND PH.D. RECIPIENT LISA ROSS



MOHAMMAD MODARRES AND UMD PRESIDENT WALLACE LOH



MOHAMMAD MODARRES WITH PANELISTS GEORGE APOSTOLAKIS, MARIA KORSNICK AND THOMAS WHITMEYER



FROM LEFT TO RIGHT: JEONG H. KIM, MOHAMMAD MODARRES, KENNETH FARQUHAR, ALI MOSLEH, WALLACE LOH, BALAKUMAR BALACHANDRAN, MARVIN ROUSH AND CLARK SCHOOL DEAN DARRYLL PINES

See more photos
from the event at:
ter.ps/re14photos

Pecht Awarded 2014 UMD Corporate Connector of the Year, Honored by Alma Mater and Receives Two Patents

MICHAEL PECHT, professor and director of the Center for Advanced Life Cycle Engineering (CALCE), was awarded the UMD Corporate Connector Award during the university's Celebration of Innovation and Partnerships held Tuesday, April 29, 2014 at University House in College Park, Maryland. Pecht's engagement with the private sector has played a large role in making UMD CALCE, headquartered at the College Park campus, the world's largest manufacturing consortium in electronic parts reliability engineering, accelerated testing and supply chain management. Over 150 corporations, federal labs, universities and leading international research centers are members.

In his role as a UMD engineering professor, Pecht has authored leading textbooks in electronic product manufacturing in China, Japan and Korea. CALCE recently received a \$750,000 gift from the Center for Automotive Safety for Pecht's work on changing the awareness of electronics reliability and safety in automotive vehicles. The funds will be used to further research on electronic systems used in automobiles.

"Through rigorous research and testing, CALCE's work has done much to improve both the safety and efficiency of consumer and business electronics in the U.S. and abroad," said Brian Darmody, Corporate Connect Chair, and Associate Vice President for Corporate and Foundation Relations. "The Council is exceptionally proud to present our inaugural award to Dr. Pecht and CALCE."



FROM LEFT, JAMES L. HUGHES, BRIAN DARMODY, UMD PRESIDENT WALLACE LOH, MICHAEL PECHT, WILLIAM KIRWAN AND PATRICK O'SHEA

In 2013 Pecht was recognized with a Distinguished Achievement Award from the University of Wisconsin-Madison School of Engineering, where he received his Ph.D. In addition, Pecht recently was awarded two patents from the United States Patent and Trademark Office. One patent is for a method to detect system anomalies in advance and determine whether they are due to natural aging or negative aging, which is a form of system degradation. Another patent is for a wireless barcode sensor that can be embedded into electronic systems to measure degradation over a period of time and possibly provide advance warning of a potential system failure.

ter.ps/mpecht

Desai's Robotics Work Highlighted



JAYDEV DESAI, along with Rao Gaullapalli, associate professor of diagnostic radiology and nuclear medicine, and neurosurgeon J. Marc Simard, both at the University of Maryland School of Medicine in Baltimore (UMB), is developing technologies that combine novel imaging techniques that allow surgeons to see deep within the brain during surgery with robotic systems that can guide more precise tissue removal.

The team's work was featured on the National Institute of Health's (NIH) National Institute of Biomedical Imaging and Bioengineering (NIBIB) website. The story, "Robots Could One Day Help Surgeons Remove Hard to Reach Brain Tumors," highlights their Minimally Invasive Neurosurgical Intracranial Robot (MINIR)—a worm-like, multi-jointed device about a half-inch wide—that could be used to remove hard-to-reach brain tumors. A surgeon can insert the robot into the brain while the patient is in an MRI scanner, then sit in a different room—and while watching the MRI scanner, remotely operate the robot deep inside

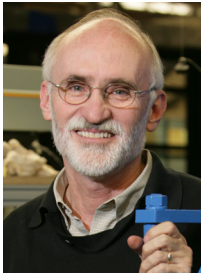
the brain and direct it to electrocauterize and aspirate the target tissue. Desai has also had his work on neurosurgical robotics featured in both National Academy of Engineering (NAE) and WTOP Radio interviews. Listen to his NAE interview at ter.ps/desaiNAE.

Desai and Associate Research Scientist Cornelia Fermuller, University of Maryland Institute for Advanced Computer Studies (UMIACS) are teaming with Assistant Professor Kelly Westlake of UMB's Department of Physical Therapy and Rehabilitation Science on a UM Research and Innovation Seed Grant. The collaborators will work on "A Robotic Grasping and Vision (GraspVis) System for Stroke Rehabilitation." GraspVis is a camera-assisted, portable, robotic exoskeleton with a custom-designed glove that could aid hand function rehabilitation for stroke survivors.

ter.ps/desai



Duncan Receives Wilson H. Elkins Professorship



Department of Mechanical Engineering Professor **JAMES DUNCAN** was awarded the Wilson H. Elkins Professorship for 2014 and 2015. The professorship was awarded to support and expand Duncan's work in the Hydrodynamics Laboratory, and for engaging graduate, undergraduate and high school students on cutting-edge research. The Elkins Professorship will also enable Duncan to investigate "anti-bubbles," a term for air-film bubbles. Unlike soap-film bubbles that are filled with air, "anti-bubbles" are filled with water encased in a combination of an air-film shell and water. Duncan and his research team have begun experiments on "anti-bubbles" to understand the dynamics of their formation and behavior.

ter.ps/duncan

Bergbreiter Receives Presidential Early Career Award for Scientists and Engineers



Associate Professor **SARAH BERGBREITER** who holds a joint appointment with the Institute for Systems Research, was honored at a White House Ceremony, April 14, 2014, as a recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE).

She is the director of the University of Maryland Microrobotics Laboratory and performs research aimed at bridging work in systems and control with research in microsystems and fabrication.

ter.ps/bergbreiter

Gupta Receives Honorary Degrees, Awarded ASME Melville Medal



Distinguished University Professor **ASHWANI GUPTA** recently received honorary degrees from three institutions.

He was awarded a Doctor of Energy and Engineering Science from the University of Wisconsin—Milwaukee and the Board of Regents of the University of Wisconsin System for his contributions to the field of energy as a prolific researcher, teacher and academic leader and for his involvement with UW—Milwaukee. He received a Higher Doctorate of Science from the University of Southampton in the United Kingdom and an honorary doctorate in mechanical engineering from King Mongkut's University of Technology North Bangkok in 2013.

Gupta along with graduate student Ahmed Khalil and collaborators Professor K. Mark Bryden of Iowa State University and Professor Sang Chun Lee of Kyungnam University, S. Korea were awarded the Melville Medal at the American Society of Mechanical Engineers (ASME) 2013 International Mechanical Engineering Congress and Exposition, which was held in San Diego, California in November. ter.ps/agupta

Staff Recognition



AMARILDO DAMATA, coordinator of graduate studies in the department, was recognized with a 2013 Outstanding Coordinator of Graduate Studies (CGS) Award. DaMata has worked as a coordinator of graduate studies in mechanical engineering for seven years and is one of only two coordinators to receive the award in 2013. In its inaugural year,

the CGS Award recognized individuals for exceptional contributions to graduate education, a graduate program and/or the graduate student experience in that program.



Assistant Director of Undergraduate Studies **TERRY ISLAND** received the 2012-2013 Academic Advisor of the Year Award for her role as a professional advisor to students. The award honors a professional, faculty or student advisor who has achieved excellence in advising undergraduate students. Island has been an advisor for mechanical engineering

undergraduate students since 2007 and was the driving force behind changing the department's advising process to give students more timely and personalized guidance.

Promotions



SARAH BERGBREITER was promoted to associate professor with tenure in 2014. Bergbreiter joined the University of Maryland in 2008 with a joint appointment in Mechanical

Engineering and Institute for Systems Research (ISR). She is also the director of the Microrobotics Laboratory.



NIKHIL CHOPRA was promoted to associate professor with tenure in 2013. Chopra is an affiliated faculty member of ISR and has been on the University of Maryland faculty since

2007. His research interests are in developing a fundamental understanding of synchronization and control of networked dynamical systems interacting over unreliable communication networks.



JAYDEV DESAI was promoted to full professor in 2014. Desai joined the Clark School faculty in 2006. He studies medical robotics, haptic interfaces for robot-assisted surgery, surgical

simulation, model-based teleoperation and cellular surgery. Desai is also the director of the Robotics, Automation and Medical Systems (RAMS) Laboratory.



F. PATRICK MCCLUSKEY was promoted to full professor in 2014. He joined the Clark School in 1997. His research focuses on high temperature and high power electronics

packaging, materials and reliability. McCluskey is also the Assistant Director for Component Research at the CALCE Electronic Products and Systems Center.

Honors & Awards

Professor **HUGH BRUCK** is the principal investigator for "Compliant Multifunctional Robotic Structures for Safety and Communication by Touch," a three-year, \$600K National Science Foundation (NSF) National Robotics Initiative award.

Associate Professor **SARAH BERGBREITER**, also affiliated with the Institute for Systems Research (ISR), was selected as one of the "25 Women in Robotics You Need to Know About" list compiled by the robotics website Robohub. Her robotics research was featured in the National Science Foundation's Science Nation.

Associate Professor **NIKIL CHOPRA** (ISR) has been appointed an associate editor of IEEE's Transactions on Automatic Control, a leading journal in the field of systems and control.

Professor **S. K. GUPTA** and several mechanical engineering alumni and students garnered awards at the 2013 Computers and Information in Engineering (CIE) Conference of the ASME (American Society of Mechanical Engineers). Gupta received the ASME CIE Division's Excellence in Research Award.

Associate Dean and Keystone Professor **WILLIAM FOURNEY** received the 2014 M.M. Frocht Award from the Society for Experimental Mechanics. The Frocht Award is presented annually in recognition of "outstanding achievement as an educator in the field of experimental mechanics."

Assistant Professor **JIN-OH HAHN** won the Korean-American Scientists and Engineers Association Young Investigator Grant in 2013 and a Young Investigator Program (YIP) award from the U.S. Office of Naval Research (ONR) under the Department of the Navy in 2014.

The Society for Health Systems (SHS) of the Institute of Industrial Engineers has named Associate Professor **JEFFREY HERRMANN** (ISR) to SHS Diplomate status in 2013 based on his contributions to healthcare operations research.

Professor **JUNGHO KIM** gave a keynote lecture at the International Conference on Multiphase Flows (ICMF) in May 2013 in Jeju, Korea. ICMF is one of the premier conferences in the field of multiphase flows and their applications.

Associate Professor **F. PATRICK MCCLUSKEY** (CALCE) is a co-principal investigator for a three-year, \$438,000 NSF GOALI (Grant Opportunities for Academic Liaisons with Industry) award for "Advanced Silicon Carbide-based

Novel Hybrid Energy Storage System for Plug-In Electric Vehicles." The team includes Professor Andre Tits (ECE/ISR) and Steven Rogers, co-founder, president and chief technology officer of Genovation, a company developing a plug-in green automobile and Assistant Professor Alireza Khaligh (ECE/ISR) who is the principal investigator.

Professor **ALI MOSLEH** was elected fellow of the American Nuclear Society, a non-profit organization that promotes awareness and understanding of the application of nuclear science and technology.

Professor **MICHAEL OHADI** has been recognized as one of the world's leading experts in heat exchangers by the European Process Intensification (EUROPIC). Ohadi was also offered a formal accreditation of expert membership in EUROPIC. Ohadi also received a 2014 University System of Maryland (USM) Regents' Faculty Award for Excellence in Innovation. This award is the Board of Regent's highest honor to recognize exemplary faculty achievement.

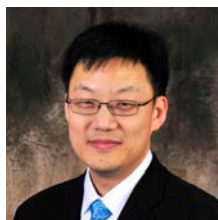
Professor **PETER SANDBORN** was elected ASME fellow, a distinction awarded to ASME members who have made significant engineering achievements. In addition, Sandborn was elevated to IEEE fellow, one of the highest distinctions awarded to IEEE members who have achieved innovation and excellence in the field of engineering.

Patents

Associate Research Professor **YUNHO HWANG** and Minta Martin Professor **REINHARD RADERMACHER**, as well as collaborators Jiazhen Ling and Osamu Kuwabara, were awarded a patent for a new type of air conditioner with a dessicant rotor and moisture-absorbing area.

Associate Professor **MIAO YU** and postdoctoral researcher Haijun Liu (Ph.D. '12) received a patent for a miniature system and method for sensing and localizing acoustic sounds.

The Department Welcomes New Faculty



PETER CHUNG joins the mechanical engineering faculty as an associate professor. Chung comes

to the university from the Army Research Lab, where he has worked since 2000. Most recently he was a mechanical engineer team leader for Interdisciplinary Computational Sciences and Engineering. He is interested in research problems at the intersection of mechanics, physics, materials science and computing. ter.ps/chung



JELENA SREBRIC joins the mechanical engineering faculty as a professor from Pennsylvania State University,

where she was a professor of architectural engineering since 2000 and an adjunct professor of mechanical and nuclear engineering since 2007. Srebric is an elected international member of the Serbian National Academy of Engineering and has served as a visiting scientist at the Harvard School of Public Health since 2008. Her research interests include multi-scale modeling of urban neighborhoods and sustainable buildings and climate change. ter.ps/srebric



SIDDARTHA DAS joins the mechanical engineering faculty as an assistant professor. He previously

held a postdoctoral position at the University of Alberta, Canada, where he received the Banting Postdoctoral Fellowship, the most prestigious such fellowship in Canada. His research interests span different areas of micro-nanoscale fluid mechanics and interactions of soft matter with fluid mechanics. ter.ps/das



Retirements

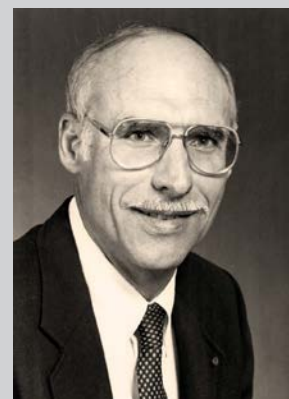
The department welcomed emeritus faculty and celebrated the work and service of Professor **DONALD B. BARKER** (pictured above, front, center) at its annual Emeritus Luncheon in September 2013. Barker (Ph.D. Engineering Mechanics, UCLA) retired in 2013 after working at UMD since 1976 in the areas of experimental mechanics, fracture mechanics, fatigue, dynamic material response and electronic packaging. He is one of the co-founders of the University of Maryland's Center for Advanced Life Cycle Engineering (CALCE).



The department also thanks Nicole J. Kim Professor **ALI MOSLEH** for his years of service to both the department and to the Center for Risk and Reliability (CRR). Mosleh is a member of the National Academy of Engineers and has served as the director of CRR since 2004 and the director of UMD's Reliability Engineering Program from 1998 to 2008. He has been a faculty member since 1988.

Mosleh has conducted research on methods for probabilistic risk analysis and reliability of complex systems and has made many contributions in the diverse fields of theory and application.

IN MEMORIAM Bergles Passes at 78



Glenn L. Martin Institute Professor of Engineering Arthur S. Bergles (78) passed away Monday, March 17, 2014. Bergles was recognized as one of the world's leading experts in thermal sciences.

Since 1999, he served as a research professor in the Department of Mechanical Engineering in addition to being a member of the department's Visiting Committee.

Dieter Establishes Capstone Design Enhancement Fund



GEORGE DIETER (RIGHT) INSPECTING A STUDENT PROJECT AT DESIGN DAY, DECEMBER 6, 2013.

Professor Emeritus George E. Dieter, Jr. and his wife Nancy Dieter have established the Capstone Design Enhancement Fund through the University of Maryland College Park Foundation to support the department's unique student engineering design curriculum.

Every semester, mechanical engineering seniors enroll in the ENME 472 Integrated Product and Process Development course. This capstone design course enables students to synthesize the skills and knowledge they have developed during their undergraduate coursework. During the semester, they work in collaborative teams to select, design, build and present a working prototype for a unique product that solves an engineering problem.

The capstone design course not only challenges students' engineering know-how, but fosters creative thinking, collaboration and problem solving. The course's main project also offers students a taste of entrepreneurship by incorporating business strategies such as target market and consumer requirement analysis to create a more marketable prototype. The semester-long project culminates when students present their prototypes to faculty, staff and special visitors during the semi-annual Design Day.

Dieter has been involved with teaching the mechanical engineering capstone design course since 1977, when he was named dean of engineering at the university. At that time, Dieter says, there was very little curriculum devoted to the design process and fewer resources were available for students taking the capstone design program. Since then, Dieter has

literally written the book on the engineering design process: *Engineering Design: A Materials and Processing Approach*. First published in 1983, the book is now in its fifth edition, and since the fourth edition, fellow Mechanical Engineering Professor Linda C. Schmidt, one of the department's leaders in engineering design curriculum, has been a co-author.

Many of the students in the capstone design course have never been involved with a hands-on building or engineering project, explains Dieter. This course gives them not only an opportunity to develop their engineering skills, but gives them experience working in teams. The students also learn how to quickly find new information to apply to a problem and gain an introduction to the use of patent literature.

Over the years, the capstone design course has developed a more structured approach, and student projects have become broader in scope and variety. Today, approximately 300 students participate in the capstone design course each year, and the diversity among student projects has increased each semester.

"Students think more creatively in a focused way. They [learn] to make decisions based on logic, rather than intuition. These skills apply to a wide variety of work experiences, not just engineering."

- George Dieter

The student projects coming out of the program are an impressive display of the engineering skills students have learned, but they also require a variety of resources such as reference materials, tools, testing equipment and special software that stretches the program's existing resources.

"They require resources that are beyond that of other lab-based courses," says Dieter, and this challenge is one of the reasons he has decided to create the Capstone Design Enhancement Fund. He wants to make resources more readily available to the students and provide support for additional resources in all design courses.

Dieter cannot stress enough the value of this curriculum, and its impact on students' experience with engineering. He has talked to many mechanical engineering alumni over the years, and even when the course was not as robust as it is now, graduates look back on the experience as a highlight of their four years. ■

LEARN MORE about how you can support faculty, students and programs in the Department of Mechanical Engineering.

www.enme.umd.edu/giving



Design Day

Every spring and fall, mechanical engineering students demonstrate their engineering know-how, creativity and talent by demonstrating what they have learned as engineering students at the Department of Mechanical Engineering's Design Day.

Design Day gives senior-level students the opportunity to present their projects from the ENME 472 Integrated Product and Process Development course. Students present their completed projects to a host of guest and faculty judges, visiting school groups, family, friends and the public. All visitors are encouraged to vote for their favorite project, and the team with the majority of votes is honored with the "People's Choice Award." Learn more at ter.ps/designday.

SPRING 2014 PEOPLE'S CHOICE WINNER

TESTUDO TRAINERS - The Spot Buddy
Students: *Corey Bloom, Will DeMore, Luke Hendrix, Kick Krochta, Yale Sosin, Vincenzo Vernaccio*

The team designed an automatic weight-lifting spotting machine that senses a user's distress during an exercise.



FALL 2013 PEOPLE'S CHOICE WINNER

THE BABY DADDIES - Child Support
Students: *Mihir Kalyani, Brandon Lee, Michael Liebler, Charles Lu, Carl McKay, Shane Vetter*

The team designed an all-purpose baby stroller with a gyroscopic seat for added stability, safety and comfort.



Terps Racing Formula SAE

The Terps Racing Formula SAE team challenged a full field at the 2013 Formula SAE Michigan competition held May 8-11 at the Michigan International Speedway in Brooklyn, Michigan. The event featured 120 teams from across the United States, Canada and Mexico, as well as teams from South America, Europe and Asia.

The Terps team surpassed most of the competition to tie for 10th place in design, missing the design finals by a slim margin. They went on to finish 14th in the skidpad event, which tests the car's cornering ability; 19th in autocross, which tests the car's maneuverability and handling qualities; 53rd in acceleration; and 33rd in sales presentation.

In fall 2013, Leonard Hamilton (M.S. '84) joined the department as an adjunct faculty member and is the new faculty advisor for the Terps Racing Formula SAE team. He is an active duty Navy captain and currently serves as an associate professor in mechanical engineering at the U.S. Naval Academy and was a faculty mentor to the USNA Formula SAE team since 2004.

Follow Terps Racing at
www.facebook.com/terpsracing

Terps Racing Baja SAE

Seventeen University of Maryland students trekked to Pittsburg, Kansas to compete in the 2014 Baja Society of Automotive Engineers (SAE) Kansas student competition. Accompanied by advisors Greg Schultz and Scott Schmidt, the students participated in a three-day competition—alongside 82 other teams from across the U.S. and abroad—that put them and their vehicle through the paces.

The UMD team, which consisted mostly of freshman, finished 4th in tractor pull, 6th in acceleration and 28th in endurance, while finishing mid-field for suspension and traction.

For many of the students, this was their first SAE competition experience. "All-in-all, it was a huge success with a young team," said Schultz. "They had a great time, learned a lot and all want to come back to Baja and Formula next year."



Profile: Rebecca Yep

Born to be a Terp

Hailing from Howard County, Maryland, Rebecca Yep (B.S. '14) was born to be a Terp. Her parents, and their families, attended the University of Maryland—it seemed like the natural choice, but according to Yep, she wasn't initially keen to go to the University of Maryland (UMD). "Everyone from [my] high school goes there; I wanted to do something different!"

Yep had a lifelong interest in math and science, but she was initially unsure of an exciting career that would best use those skills. It wasn't until she attended a career fair in high school, where she saw a display from the local community college engineering department showing the breadth of what engineers could accomplish—from space exploration to Hollywood special effects—that she considered engineering that career.

Family tradition and Yep's experiences at a UMD Exploring Engineering summer camp for high school girls, led her to decide on engineering at Maryland. Led by Paige Smith, the UMD summer camp exposed Yep to the University's wind tunnel, nuclear reactor and neutral buoyancy tank. "All of which were on campus, for crying out loud," said Yep, "How could I not have a passion for engineering after that?"

Yep was involved in numerous academic and engineering activities, including the Keystone Engineering program—where she was also a teaching fellow for the Dynamics course. Most recently, Yep swore the oath of the Order of the Engineer and was accepted into the University Medallion Society.

As a student, she furthered her engineering goals by interning at General Electric Healthcare and at Lockheed Martin Missiles and Fire Control, where she worked with the

"Engineers, like superheroes, make an impact. We help people lead better, healthier and more efficient lives."

- Rebecca Yep



team designing and testing the F-35 Lightning fighter plane.

Not only did Yep excel in her studies, but she was also a talented athlete. She captained UMD's Varsity Cross Country and Track and Field teams and served on regional athletic committees. Yep was a Cross Country MVP, named to the ACC All-Academic Team and selected as an Arthur Ashe Sports Scholar finalist. In addition, she helped her team win the UMD President's Cup awarded to the team with the highest cumulative grade point average.

Between academics, internships and athletics, Yep was forging a successful undergraduate career, but during a volunteer experience with elementary school children from lower-income areas, she became stumped by a seemingly simple question:

What is an engineer?

Yep discovered it was difficult to express to the children what exactly an engineer was—especially when compared to more identifiable jobs such as veterinarian or teacher.

Mechanical engineering students have unique qualities that allow them to help countless people in new and exciting ways, however, it is often difficult to define what qualities define

an engineer.

In her Spring 2014 undergraduate commencement speech, Yep sought to answer this difficult question.

"Even I didn't know exactly what an engineer was, only that my dad was one and that it seemed like a good way to help people," said Yep, who went on to relay her definition of an engineer.

"We are creators and innovators, brilliant minds who tackle problems in new ways. We venture far out into space and deep into the ocean. We bend wind and experiment with nuclear physics. We build safe and warm buildings for the masses, provide means for people to get across the globe, both physically and virtually, and deliver water and education to the poor. We give humans the ability to fly, to 3D print new limbs, to create futuristic robots, all while obeying the laws of physics."

Post-graduation, Yep will work for Boeing in Philadelphia. She is grateful to her parents and family, her friends, her professors, her coaches and the wonderful administrative staff of the engineering department.

In her commencement speech, Yep exclaimed, "Next time people ask what an engineer is, Terps, be ready to reply, 'I am'." ■

Students Celebrate Award-winning Achievements

Ph.D. student **SAGAR CHOWDHURY** won the 2013 ISR George Harhalakis Outstanding Systems Engineering Graduate Student Award. He also was awarded third place in the 2013 Dean's Doctoral and Master's Student Research Awards competition for his work on "Planning for Automated Optical Micromanipulation of Biological Cells." Sagar's research is aimed at turning optical tweezers into autonomous robots that can manipulate microscale objects.

Graduate student **CALEB HOLLOWAY** was awarded an L-3 Communications Graduate Fellowship for the 2013-2014 academic year. Advised by Professor Avram Bar-Cohen, Holloway's research involves the thermal management of high-powered electronics with the forced flow of fluid undergoing phase change in microscale channels.

Two doctoral candidates received prestigious university dissertation awards for the 2013-14 academic year. **ZHENG JIA** won the Graduate Dean's Dissertation Fellowship and both Jia and **JIAJUN XU** won the Ann G. Wylie Dissertation Fellowship for 2013-2014.

Doctoral students **ZOHREH GHORBANI** and **SHUZE ZHU** were awarded Graduate Student Summer Research Fellowships in 2013. Both students received \$5,000 stipends to prepare or complete a benchmark in their programs. Ghorbani was also awarded a Graduate Student Summer Research Fellowship for 2014.

Graduate students **KENNY MAHAN**, **JINGSHI MENG**, and **YONG SUN** received the George R. Irwin Centennial Research Award, which subsidizes travel so students can attend and present their research in fracture mechanics or experimental mechanics at technical meetings or conferences.

Postdoctoral researcher **KRISHNA KAIPA**, mechanical engineering Ph.D. students **CARLOS MORATO** and **B. ZHAO** received the Computer-Aided Product and Process Development Technical Committee's 2013 Prakash Krishnaswami Best Paper Award for "Safe Human Robot Interaction by Using Exteroceptive Sensing Based Human Modeling" at the 2013 ASME Computers and Information in Engineering Conference in Portland, Ore.

Graduate students **CELESTE POLEY** and **LUKE ROBERTS** have recently been awarded three-year National Science Foundation (NSF) Graduate Research Fellowships. Poley is advised by Balakumar Balachandran and is performing research in robot end effector dynamics. Roberts, a second-year Ph.D. student advised by S.K. Gupta, is involved in the Robo Raven micro air vehicle project (read more on page 9).

Ph.D. candidate **SUBHASIS MUKHERJEE** won first prize in the Modeling and Simulation category for his oral presentation on new solder interconnects at the spring 2013 Graduate Research Interaction Day (GRID), an event sponsored by UMD's Graduate Student Government to help graduate students hone research presentation skills.

In both 2012 and 2013, a team of UMD students advised by Yunho Hwang, associate director of UMD's Center for Environmental Energy Engineering, won the MaxTech and Beyond Design Competition for Ultra-Low Energy-Use Appliances and Equipment. Most recently, the UMD Dryer team was awarded the first place gold medal for developing an energy-saving, two-stage, heat pump clothes dryer (read more on page 6).

In fall 2013, three graduate students in the department, **JAEMI LEE HERZBERGER**, **ALEX SCAMMELL** and **ELIZABETH SAURBRAUM**, were awarded NASA Space Technology Research Fellowships. The fellowships provide graduate students with funding to facilitate technological growth and improvement in space technology.

Four students in the department were selected for the 2014 Future Faculty Program. **SAEED ALTHAMER**, a graduate student in mechanics and materials, is advised by Minta Martin Professor Amr Baz. **PAUL ANDERSON**, a graduate student in thermal, fluids and energy sciences, is advised by Associate Professor Peter Sunderland. **HANNES GREVE**, a graduate student in electronic products and systems, is advised by Associate Professor F. Patrick McCluskey, and **AJAY SINGH**, a graduate student in thermal, fluids and energy sciences, is advised by Assistant Professor Michael J. Gollner.



UMD TEAM FOR THE 2013 MAXTECH AND BEYOND DESIGN COMPETITION FOR ULTRA-LOW-ENERGY-USE APPLIANCES AND EQUIPMENT

Students Recognized at Annual Honors & Award Ceremonies

Twelve mechanical engineering undergraduate students were recognized for their outstanding achievements at the 2014 A. James Clark School of Engineering Honors and Award Ceremony.

DEPARTMENT OF MECHANICAL ENGINEERING ACADEMIC ACHIEVEMENT AWARD WINNERS

This award recognizes juniors in mechanical engineering who have attained the highest overall academic average.

Ralph Fairbanks

Andrew Sisler

Jeeven Bhathal Hugh

DEPARTMENT OF MECHANICAL ENGINEERING CHAIRMAN'S AWARD WINNERS

This award is presented for excellence in academics, outstanding service to, or leadership in, the department.

Luke Catherine

Eric LaRoche

Scott Hemley

Emily Posey

Eric Kazyak

Alek Williams

Abisola Kusimo

OUTSTANDING ENGINEERING CO-OP/INTERN AWARD WINNER

Haley Crock

CENTER FOR MINORITIES IN SCIENCE AND ENGINEERING SERVICE AWARD WINNER AND THE KIM BORSAVAGE AND PAMELA J. STONE STUDENT AWARD WINNER

Abisola Kusimo

DINAH BERMAN MEMORIAL AWARD WINNER

Sarah Andrews



MECHANICAL ENGINEERING FACULTY, FRIENDS AND STUDENTS CELEBRATED THE ACHIEVEMENTS AND SUCCESSES OF THE DEPARTMENT'S GRADUATE STUDENTS DURING THE SPRING 2014 GRADUATE AWARDS CEREMONY HELD MAY 1, 2014, IN THE SAMUEL RIGGS IV ALUMNI CENTER.



FROM LEFT TO RIGHT: ABISOLA KUSIMO, LUKE CATHERINE, RALPH FAIRBANKS, ANDREW SISLER, ERIC LAROCHE, EMILY POSEY, ALEK WILLIAMS, ERIC KAZYAK

Alumni Help Students Explore Career Paths in Mechanical Engineering

The Department of Mechanical Engineering would like to thank the UMD alumni who participated in the Fall 2013 and Spring 2014 semesters of Mechanical Engineering's ENME 201 course, Careers in Mechanical Engineering.

Alumni participants gave presentations and shared their personal experiences as engineers to help students gain a better understanding of what career opportunities are available to them, the important roles they can play in society as engineers and what it takes to lead a successful professional life.

FALL 2013 AND SPRING 2014 CAREER PATH SPEAKERS INCLUDED:

LUKE CURRANO (Mechanical Engineering, B.S. '00, M.S. '02) Senior MEMS Engineer, Johns Hopkins University Applied Physics Lab

AUL HICKEY (Mechanical Engineering, B.S. '93; Sustainable Energy, M.S. '11) Entrepreneur

SAM HOLLENBACH (Mechanical Engineering, B.S. '07) Senior Innovation Engineer Specializing in Digital Product, Under Armour

STEVE HOGAN (Mechanical Engineering, B.S. '85) Sector Vice President and General Manager, Integrated Logistics Modernization Division, Northrop Grumman Technical Services

ASIF "CAESAR" HUSSAIN (Mechanical Engineering, B.S. '94) Senior Vice President, North America Foster Wheeler Corporation

MICHAEL MILLER (Mechanical Engineering, B.S. '79, M.S. '84) Vice President of Science and Technology, Space Science Programs at Orbital Sciences

CHAD SCHNEIDER (Mechanical Engineering, B.S. '99) President/Founder Rt. 3 Labs

SHELDON SHAPIRO (Fire Protection Engineering, B.S. '90) Chief Executive Officer of Shapiro & Duncan

DOUG SKORUPSKI (Mechanical Engineering, B.S. '92) Manager of Technical Strategy, Volkswagen of America

DONNA WILLIAMS (Mechanical Engineering, B.S. '90) Technical Assistant to the Director of the Office of New Reactors at the Nuclear Regulatory Commission

If you are interested in participating in ENME 201 as a Career Paths speaker, contact: **KENNETH KIGER**, professor and director, undergraduate studies, kkiger@umd.edu

Alumni News Notes

BRAD BOYERINAS (Ph.D. '13) published work in the April 9, 2014, issue of Nano Letters on a new breakthrough in hydrogen energy storage. His discovery, the formation of novel nanostructures in Pd films during hydrogenation through epitaxial control, is a significant breakthrough for the use of these materials in renewable hydrogen energy applications. The nanostructures can reduce defects and fractures that compromise performance for hydrogen energy storage.

JEONG H. KIM (Ph.D. '91) received the French Legion of Honor, France's highest award, for his contributions to global technology research while he served as president of Bell Labs, a research organization owned by French global telecommunications equipment company Alcatel-Lucent.

ERIC LAROCHE (B.S. '14) won a top spot in Infiniti's Performance Engineering Academy, securing a 12-month work placement with Infiniti Red Bull Racing in the U.K.

YUXIANG LIU (Ph.D. '11) is an assistant professor in mechanical engineering at the Worcester Polytechnic Institute in Massachusetts.

ALEX MEHR (Ph.D. '03) was featured in the March 3, 2014 issue of Forbes Magazine. Mehr is co-founder of Zoosk, an online romantic social network and dating service. The Forbes article on "Up-and-Comers: Entrepreneurs Who Want To Find You Love" features both Mehr and Zoosk co-founder and fellow UMD graduate Shayam Zadeh.

RAKESH NAGI (Ph.D. '91) has been named the Donald Biggar Willett Professor and Head of the Department of Industrial and Enterprise Systems Engineering at the University of Illinois at Urbana-Champaign (UIUC).

RICHARD STAMPER (Ph.D. '97) was made dean of faculty at Rose Hulman Institute of Technology.

WE WANT TO HEAR FROM YOU!!

METRICS is designed to keep our readers informed about the research, activities and accomplishments in the Department of Mechanical Engineering. We would like you to keep us informed about your activities and accomplishments so we can share them with our readers.

Please send your alumni news to:

umdme-comms@umd.edu



You can now connect with Mechanical Engineering on Twitter!
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You can also still find us on the web at
www.enme.umd.edu



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ONE SCHOLARSHIP CAN MAKE ALL THE DIFFERENCE

At the A. James Clark School of Engineering, and in the Department of Mechanical Engineering, we are dedicated to recruiting the most talented and diverse undergraduate students and providing them with unique education and research experiences. Most importantly, we believe that these opportunities should be made available to as many well deserving students as possible, regardless of their economic background.

Unfortunately, many Clark School students struggle with tuition costs. For the 2012-2013 academic year:

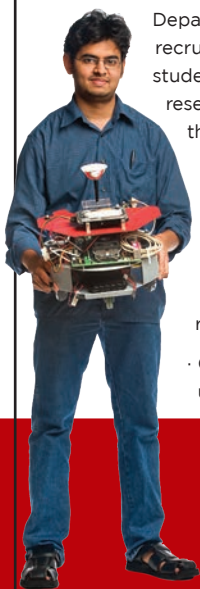
- More than 600 Clark School undergraduate students received Federal Pell Grants.
- Clark School Pell Grant students had a cumulative unmet need of \$3,877,197.

- Almost all Pell Grant recipients have a family income at or below 250% of the poverty line.

Many of these students must delay or abandon their undergraduate education altogether. In an effort to ease the financial pressure on our students, the University of Maryland has created the **TerpStart** Matching Scholarship Program. With a minimum contribution of \$30,000 payable over five years, you can establish a scholarship that will help the Clark School's neediest students and give them the chance to follow their passion for engineering.

To ensure that your scholarship has the greatest impact, the University of Maryland will match the spendable income generated each year by the endowment in perpetuity. That means your gift's impact is doubled forever. Your scholarship will support Clark School Students for many years to come.

For more information or to make a gift, contact:
Sammy Popat, Director of Development, Individual Gifts
301-405-0224 or spopat@umd.edu



TerpStart MATCHING SCHOLARSHIP PROGRAM

Mpact

WEEK OCT. 16-22, 2014

Learn more about how the Department of Mechanical Engineering is making impacts by attending this year's Mpact Week.

LEARN MORE AT:

www.eng.umd.edu/mpact

