University of Delaware

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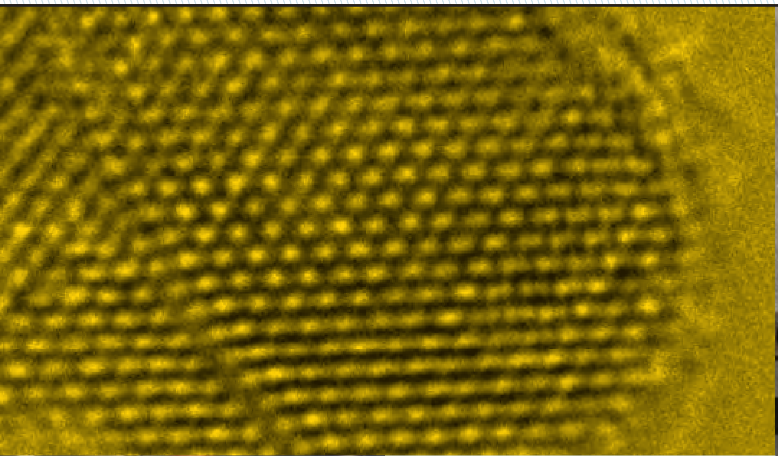
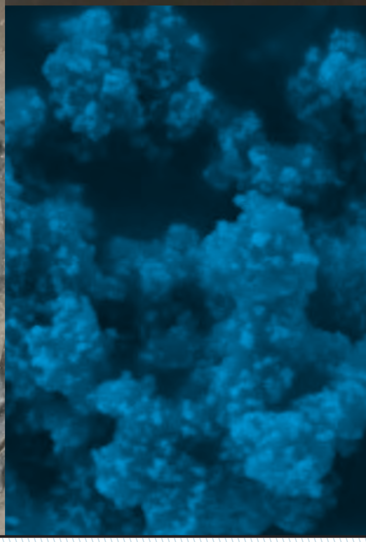
MECHANICAL ENGINEERING

2018 NEWS





INSIDE

SPOTLIGHTS ON OUR HIGH-IMPACT, MULTIDISCIPLINARY RESEARCH

BIOMEDICAL ENGINEERING | COMPOSITES AND ADVANCED MATERIALS | CLEAN ENERGY
NANOTECHNOLOGY | COMPOSITES & ADVANCED MATERIALS | ROBOTICS AND CONTROLS

UD College of Engineering

FROM CLASSICAL MECHANICS TO MODERN IMPACT

Many of society's most promising technological advances are being developed by mechanical engineers. From automated vehicles to smarter materials to modern power sources to novel applications of robotics and more, we are designing, fabricating, and testing tomorrow's innovations today here at the University of Delaware.

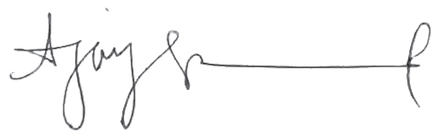
Our department received a major boost with the recent announcement of a $1 million gift to establish the Terri Connor Kelly and John Kelly Career Development Professorship in Mechanical Engineering. We are deeply grateful to Terri (BSME, COE '83) and John Kelly (BE '83) for their magnificent gift, which will play a critical role in recognizing and rewarding outstanding scholarship and mentorship in our department. We are proud to announce that Prof. Andreas Malikopoulos has been named the inaugural Career Development Professor under this endowment (see inside back cover).

Our faculty and students push the field of mechanical engineering forward, and I am consistently impressed by their ingenuity and dedication. Our professors have earned national recognition from organizations such as the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, the National Institutes of Health, and the American Society of Engineering Education, and they have also received accolades for community service and engagement. Our graduate students are not only scholars—they are also inventors, entrepreneurs and award-winning teachers. Our undergraduate students master concepts on paper and then utilize our Design Studio to design and build new products. Our alumni blaze influential paths in industry and academia.

The pages that follow offer a snapshot of our priorities and accomplishments over the past year, and I hope you will follow along as we embark on even more exciting intellectual adventures in the months to come. For one, we are expanding research and education in additive manufacturing and making strategic hires in this area. This is an interdisciplinary effort at the University of Delaware that will include several mechanical engineers and colleagues at the world-renowned Center for Composite Materials. In another interdisciplinary project, a team of mechanical engineers is working with colleagues in UD's College of Agricultural and Natural Resources to deploy robots to optimize maize crop production. We also have a promising collaboration with the Delaware Department of Transportation to deploy two autonomous shuttles to UD's campus in the near future. Our biomechanical engineers are collaborating with physical therapists to determine the best ways to help people maintain mobility after an injury or stroke. These are just a few of many developments we are proud to share. We have additional interdisciplinary projects on the horizon, and we are expanding our industry partnerships to give faculty and students even more opportunities to change the world. Our department is also growing and becoming more diverse—trends we plan to continue.

Mechanical engineering is one of the foundational disciplines of engineering, and its role in improving the health of our planet and the quality of life of its inhabitants continues to grow. At the University of Delaware Department of Mechanical Engineering, we have 126 years of history behind us and an even brighter future ahead. Philanthropy is vital to our progress, and we are again grateful to Terri and John Kelly for endowing our department's first Career Development Professorship. To keep up with our news and events and learn how to get involved, visit me.udel.edu and join the conversation via the social media channels listed on this page.

AJAY PRASAD



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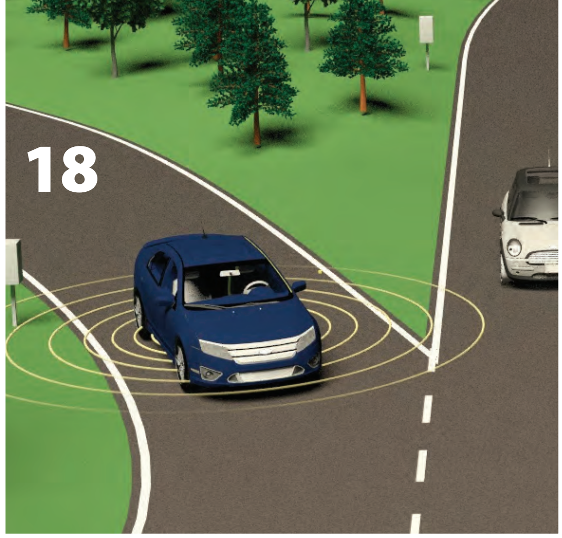


IN THIS ISSUE

High-impact, multidisciplinary research

The broadest of the engineering disciplines, mechanical engineering offers a wide range of research and career opportunities for those committed to advancing innovations to enhance quality of life.

The department is recognized for our solid technical curriculum, internationally recognized faculty and world-class, high-impact research in nearly every aspect of modern mechanical engineering.

Focusing on critical areas ranging from sustainable energy to human health and national security, our faculty and students are making bold steps toward new technologies and better solutions to contemporary problems.

The Department of Mechanical Engineering houses the Center for Biomechanical Engineering Research (CBER) and the Center for Fuel Cells and Batteries (CFCB). Other affiliated research centers and institutes include the Center for Composite Materials (CCM), the Delaware Rehabilitation Institute (DRI) and the Delaware Energy Institute (DEI). Several critical college and university-wide academic programs and research centers originated in our department.

Reflecting the interdisciplinary nature of our research, many of our faculty members hold joint or affiliated appointments in other departments.

Research expenditures of more than $7 million allow us to constantly strive to expand knowledge of the world around us in our five core research areas:

- **Biomedical Engineering**
- **Clean Energy and Environment**
- **Composites and Advanced Materials**
- **Nanotechnology**
- **Robotics and Controls**

Enrollment

(Spring 2018)

562 ME Undergraduate
101 ME Graduate
663 ME Total

Degrees Awarded

(AY 2016–2017)

122 Bachelor's
9 Ph.D.

Faculty

(Current)

5 Named/Chaired Professorships
13 Full Professors
8 Associate Professors
6 Assistant Professors

Faculty Publications

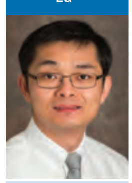
173 Journal Articles & Book Chapters
125 Conference Papers/Presentations
7 Journal Editors
36 Associate Editors

FACULTY MATRIX

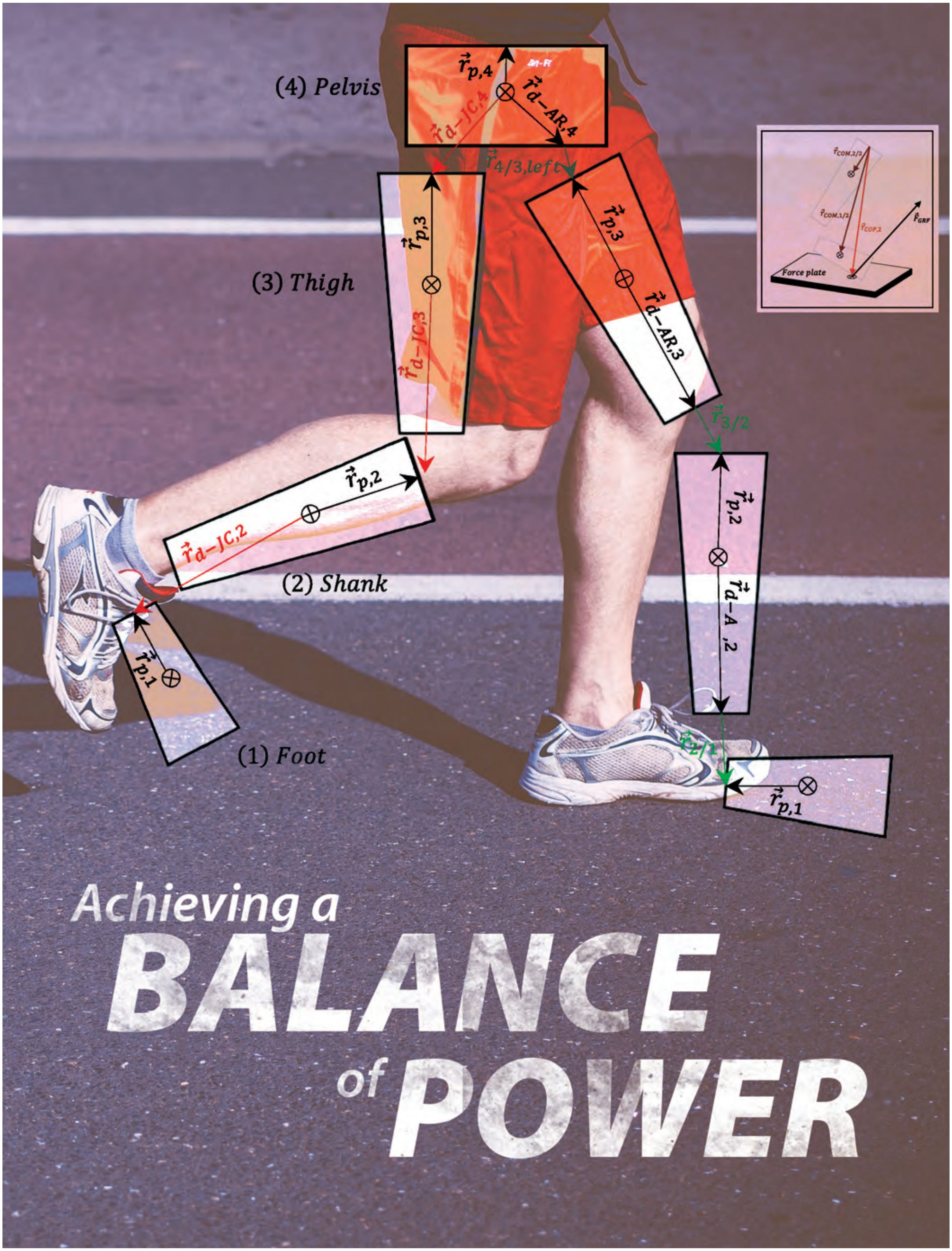
Mechanical Engineering Faculty Research

	Suresh Advani	Dennis Assanis	Thomas Buchanan	Jenni Buckley	David Burris	Tsu-Wei Chou	Heather Doty
							
Biomedical Engineering			■	■	■		
Clean Energy and Environment	■	■			■		
Composites and Advanced Materials	■				■	■	■
Nanotechnology					■	■	■
Robotics and Controls							

	Joseph Feser	Jack Gillespie	James Glancey	Jill Higginson	Zubaer Hossein	Guoquan Huang	Michael Keefe
							
Biomedical Engineering		■		■			
Clean Energy and Environment	■	■			■		
Composites and Advanced Materials	■	■	■		■		■
Nanotechnology	■	■			■		
Robotics and Controls						■	

	Joseph Kuehl	X. Lucas Lu	Andreas Malikopoulos	Kurt Manal	Ioannis Poulakakis	Ajay Prasad	Valery Roy
							
Biomedical Engineering	■	■		■		■	
Clean Energy and Environment	■					■	■
Composites and Advanced Materials							
Nanotechnology						■	
Robotics and Controls			■		■		

	Michael Santare	Leonard Schwartz	Herbert Tanner	Erik Thostenson	Lian-Ping Wang	Liyun Wang	Bingqing Wei
							
Biomedical Engineering	■				■	■	
Clean Energy and Environment	■	■			■		■
Composites and Advanced Materials	■			■			■
Nanotechnology				■	■		■
Robotics and Controls			■				



Achieving a BALANCE of POWER

Photo by Clem Onojeghuo on Unsplash

UD research team solves mathematical discrepancy in biomechanics

Every engineer knows that the two sides of any equation should be equal. But when you are dealing with experimental data, sometimes the numbers don't match up. When ANAHID EBRAHIMI, who recently earned a doctoral degree in mechanical engineering at UD, noticed that an important equation in biomechanics never balanced, she was determined to figure out why.

Ebrahimi worked with an interdisciplinary research team that included JILL HIGGINSON and STEVEN STANHOPE, both professors of mechanical engineering at UD, to solve the 6 degree-of-freedom segmental power imbalance in human movement analysis. Their results were published in the January 2018 issue of the *Journal of Biomechanics*.

Human movement analysis can help a range of people—from stroke survivors learning how to walk again to athletes optimizing their performance. By examining how much energy is used by different segments of the lower body, such as the foot, shank, thigh or pelvis, during each step, a physical therapist or other health professional can help people walk or run safely and efficiently.

Researchers calculate these values, known as segmental power, in two theoretically equivalent ways. The kinetic method uses segment endpoint dynamics, while the kinematic method measures the rate of change in a segment's mechanical energy state. Both are calculated in a model with six degrees of freedom to account for all the ways a joint can move: forward and backward, up and down, left and right and twists around three planes.

The kinetic and kinematic methods should yield equal results, but in experiments with segments proximal to the foot, they never quite matched. The difference between the results of the two methods has often been referred to as the "power imbalance." This imbalance frustrated Ebrahimi, who is now a post-doctoral associate at the University of Wisconsin-Madison.

"It was a known discrepancy, but no one was talking about why there was a discrepancy," she said.

Through a series of arduous calculations, Ebrahimi deduced that researchers have been ignoring a value called power due to relative segment endpoint displacement.

"People didn't account for work due to sliding at the joint," said Higginson.

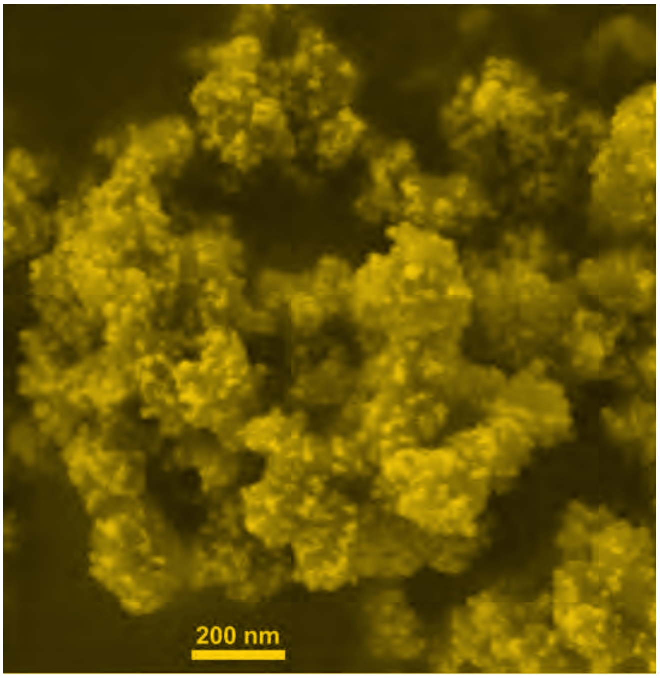
When the new methods were tested with experimental data, the power imbalance for the shank (lower leg) was reduced by 98.4 percent, the thigh by 95.7 percent and the pelvis by 95.6 percent.

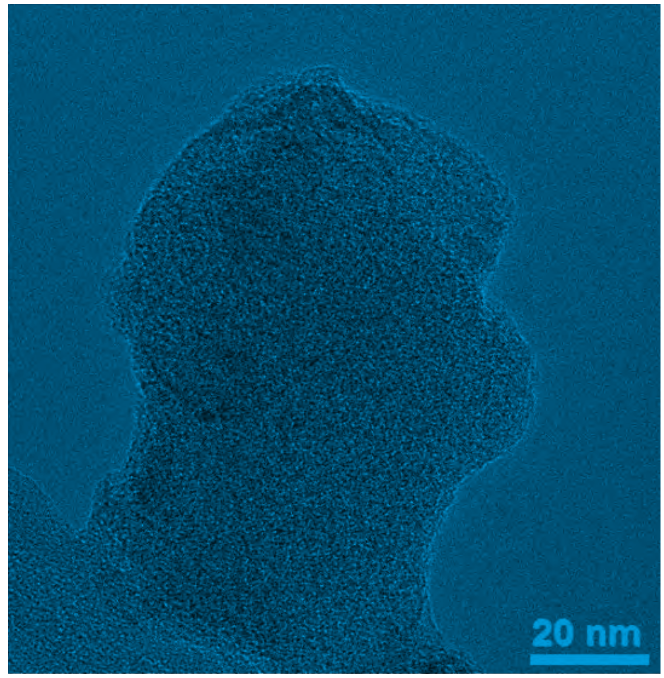
"As engineers and scientists, we want to do our calculations correctly and understand what our calculations mean," said Ebrahimi. This finding can help other biomechanics researchers develop more accurate models and could accelerate the development of prosthetics and other medical devices for movement.

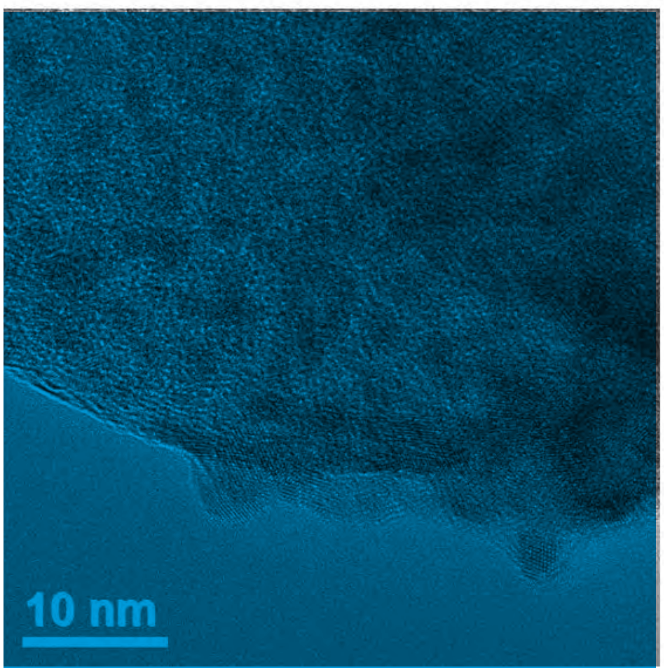
The paper's authors also included John D. Collins, a doctoral student in biomechanics and movement science at UD; Thomas M. Kepple, chief science officer at C-Motion, Inc.; and Kota Z. Takahashi, an assistant professor of biomechanics at the University of Nebraska at Omaha.

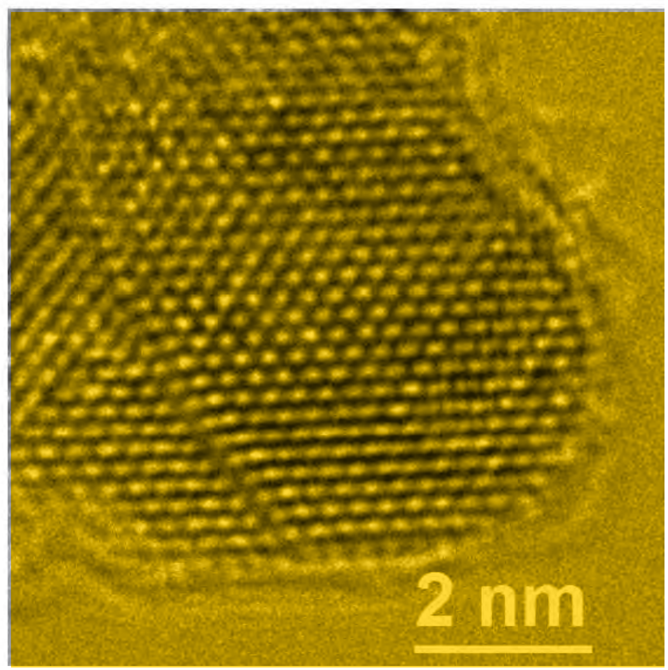
This material was based upon work supported by the National Science Foundation (NSF) Graduate Research Fellowship Grant No. 1247394, the Center for Research in Human Movement Variability of the University of Nebraska at Omaha and the National Institute of Health (P20GM109090), the University of Delaware College of Health Sciences, and the Mechanical Engineering Department Helwig Fellowship. It was also supported by the BADER consortium, a Department of Defense Congressionally Directed Medical Research Programs cooperative agreement (W81XWH-11-2-022).

DOI: https://doi.org/10.1016/j.jbiomech.2017.10.034









MAKING BETTER MATERIALS FOR FUEL CELLS

UD researchers make material to make fuel cells more durable, less expensive

Take a ride on the University of Delaware's Fuel Cell bus, and you see how fuel cells can power vehicles in an eco-friendly way.

Toyota, Hyundai and Honda have released fuel cell vehicles, and carmakers such as GM, BMW and VW are working on prototypes. If their power sources lasted longer and cost less, fuel cell vehicles could go mainstream faster.

Now, a team of engineers at UD has developed a technology that could make fuel cells cheaper and more durable. They described their results in a paper published in *Nature Communications* in September 2017.

CLEANER ENERGY, LOWER COST

Hydrogen-powered fuel cells are a green alternative to internal combustion engines because they produce power through electrochemical reactions, leaving no pollution behind. Catalysts spur these electrochemical reactions, and platinum is the most common catalyst in the type of fuel cells used in vehicles.

However, platinum is expensive —around $30,000 per kilogram. Instead, the UD team made a catalyst of tungsten carbide, which goes for around $150 per kilogram. They produced tungsten carbide nanoparticles in a novel way, much smaller and more scalable than previous methods.

"The material is typically made at very high temperatures, about 1,500 Celsius, and at these temperatures, it grows big and has little surface area for chemistry to take place on," Vlachos said. "Our approach is one of the first to make nanoscale material of high surface area that can be commercially relevant for catalysis."

The researchers made tungsten carbide nanoparticles using hydrothermal treatment, separation, reduction, carburization and more.

"We can isolate the individual tungsten carbide nanoparticles during the process and make a very uniform distribution of particle size," Zheng said.

Next, the researchers incorporated the tungsten carbide nanoparticles into a fuel cell membrane. Automotive fuel cells, proton exchange membrane fuel cells (PEMFCs), contain a polymeric membrane that separates the cathode from the anode. This membrane wears down over time, especially if it undergoes too many wet/dry cycles as water and heat are produced during electrochemical reactions. When tungsten carbide is incorporated into the fuel cell membrane, it humidifies it at a level that optimizes performance.

"The tungsten carbide catalyst improves the water management of fuel cells and reduces the burden of the humidification system," Wang said.

The team also found that tungsten carbide captures damaging free radicals before they can degrade the fuel cell membrane. As a result, membranes with tungsten carbide nanoparticles last longer than traditional ones.

"The low-cost catalyst we have developed can be incorporated within the membrane to improve performance and power density," Prasad said. "As a result, the physical size of the fuel cell stack can be reduced for the same power, making it lighter and cheaper. Furthermore, our catalyst is able to deliver higher performance without sacrificing durability, which is a big improvement over similar efforts by other groups."

The team also used a scanning electron microscope and focused ion beam to obtain thin-slice images of the membrane, which they analyzed with software, rebuilding the three-dimensional structure of the membranes to determine fuel cell longevity. They have applied for a patent and hope to commercialize their technology.

This work was conducted with support form the Catalysis Center for Energy Innovation, an Energy Frontier Research Center funded by the U.S. DOE, Office of Science, Office of Basic Energy Sciences under Award No. DE-SC0001004 and the University of Delaware's Fuel Cell Bus Program, Funded by the Federal Transit Administration at the Center for Fuel Cells and Batteries at the University of Delaware.

DOI: https://doi.org/10.1038/s41467-017-00507-6

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STEPHEN A. GILES, Graduate Student in the Department of Chemical and Biomolecular Engineering

AJAY K. PRASAD, Engineering Alumni Distinguished Professor and Chair of the Department of Mechanical Engineering

SURESH G. ADVANI, George W. Laird Professor in the Department of Mechanical Engineering

YUSHAN YAN, Distinguished Engineering Professor in the Department of Chemical and Biomolecular Engineering and Associate Dean for Research and Entrepreneurship for the College of Engineering

DIONISIOS VLACHOS, Allan and Myra Ferguson Professor in the Department of Chemical and Biomolecular Engineering and Director of the Catalysis Center for Energy Innovation.

REDUCING RADIATION

Paper reports successful use of nanocomposites to absorb electromagnetic radiation

The rapid development of modern electronic equipment and wireless devices has resulted in severe electromagnetic (EM) radiation pollution, which has implications in the health of creatures from fruit flies and frogs to horses and humans.

In addition, EM radiation can affect the normal functioning of electronics. These issues have prompted researchers to explore ways to create materials that can effectively absorb EM waves.

According to TSU-WEI CHOU, Pierre S. DuPont Chair of Engineering at the University of Delaware, carbon nanotubes (CNTs) offer the unique potential to be excellent EM wave absorbents, with most of the research effort to date focused on CNTs decorated with magnetic metal or metal oxide particles for enhancing magnetic attenuation.

However, the anticipated improvement in EM wave absorption performance has often been hindered by the poor dispersion of CNTs.

Now, he and colleagues, including JOHN XIAO, UD professor of physics, and visiting scholar JINSONG LI, have demonstrated that CNT films can facilitate the dispersion of CNTs in the composite matrix.

Their work is documented in a paper, "Superb Electromagnetic Wave-Absorbing Composites Based on Large-Scale Graphene and Carbon Nanotube Films," published online in *Scientific Reports* in May 2017.

"We found that the dispersion of Fe3O4 [iron oxide] nanoparticles on the surface of CNTs can actually improve permeability and impedance matching — properties that promote absorption of EM waves — as well as facilitate processing," Chou says.

The researchers also demonstrated that graphene, a very thin layer of pure carbon, can be used as a substrate.

"The resulting composite exhibits exceptionally high wave absorption capacity even at a very low thickness," Chou says.

The materials have applications in equipment-level shielding, protection from high-intensity radiation fields, anechoic chambers and human exposure mitigation.

The paper was co-authored by Jinsong Li (School of Physics and Nuclear Energy Engineering, Beihang University, China), Weibang Lu (Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, China), Jonghwan Suhr (Department of Polymer Science and Engineering, Sungkyunkwan University, Republic of Korea), Hang Chen (UD Department of Physics and Astronomy), Xiao and Chou.

DOI: https://doi.org/10.1038/s41598-017-02639-7

DISCOVERY COULD MAKE ULTRA-POWERFUL BATTERIES SAFER, MORE EFFICIENT

Professor Bingqing Wei leads team to curb formation of harmful dendrites in lithium metal batteries

Scientists all over the world are looking for ways to make rechargeable batteries safer, lighter, and more powerful.

Now, an international team of researchers led by BINGQING WEI, a professor of mechanical engineering at the University of Delaware and the director of the Center for Fuel Cells and Batteries, is doing work that could lay the foundation for more widespread use of lithium metal batteries, which have more capacity than the lithium ion batteries commonly used in consumer electronics today. The team developed a method to mitigate dendrite formation in lithium metal batteries, which they described in a paper published in *Nano Letters* in March 2018.

In a lithium ion battery, the anode is made of a material with lithium ions bound to it. The lithium ions flow to the cathode. In a lithium metal battery, the anode is made of lithium metal. Rechargeable batteries made of lithium metal hold promise because lithium is the most electrically positive metal and has a very high capacity.

“Theoretically, lithium metal is one of the best choices for batteries, but it is hard to handle in practice,” Wei said.

Lithium metal batteries have been inefficient, unstable and even a fire hazard thus far. Their performance is hampered by lithium dendrites, formations that look like tiny stalagmites made of lithium deposits. As a battery is being used, lithium ions collect on the anode. Over time, the lithium deposits become non-uniform, leading to the formations of these dendrites, which can cause the battery to short circuit.

A NEW UNDERSTANDING

Research groups around the world have tried many techniques to suppress the formation and growth of these dendrites. In the literature, Wei found that almost all of the techniques applied could be understood under an umbrella: Introducing a layer of porous material into the system could deter dendrites from collecting on the anode. Using mathematical modeling, the research team found that a porous material suppressed the initiation and growth of dendrites. The dendrites that did form were 75 percent shorter than those that formed in systems that lacked the porous membrane. Then the team fabricated a membrane made of tiny wires of porous silicon nitride that measured less than one millionth of a meter each. They integrated this membrane into lithium metal cells in a battery and ran it for 3,000 hours. No dendrites grew. “This fundamental understanding may not be limited to the silicon nitride we used,” Wei said. “Other porous structures may do this too.” This principle may also extend to other battery systems, he said. “In this field of metal-based batteries, this is up-to-date understanding,” he said. “This is the kind of work that could have high impact.”

Wei’s collaborators on this paper include: Nan Li, Wenfei Wei, Keyu Xie, Kai Yuan, Qiang Song, Hejun Li and Chao Shen of the Northwestern Polytechnical University and Shaanxi Joint Laboratory of Graphene, Xi’an, China; Jinwang Tan and Emily M. Ryan of Boston University; Lin Zhang and Ling Liu of Utah State University; and Xiaodong Luo of Chongqing University of Science and Technology in Chongqing, China.

This work was supported by the National Natural Science Foundation of China, the Fundamental Research Funds for the Central Universities, the Key R&D Program of Shaanxi, the TOP International University Visiting Program for Outstanding Young Scholars of Northwestern Polytechnical University and the Natural Science Foundation of SZU.

DOI: https://doi.org/10.1021/acs.nanolett.8b00183

WHICH DRONE SHOULD YOU TRUST?

UD research team optimizing radiation detection by drone networks

Drones are increasingly important tools for law enforcement agencies. Among other uses, drones can be equipped with sensors to detect radioactive material which is illicitly transported.

When a squad of robotic drones collects information from their onboard radiation sensors, each gathers slightly different intel, depending on how they move relative to their suspect carrier. One key idea is that drones can communicate with some of the other drones and share their data with them. This leaves the question: Which drone is best suited to be the group's decision-maker? Should it be the one who has heard from most other drones, or the one which flew closer to the suspect carrier? A team of researchers at the University of Delaware has developed a method to quantify the decision-making accuracy of autonomous robotic drones within a network, which they described in the journal Autonomous Robots.

SEND IN THE DRONES

For a century, scientists have used Geiger counters to detect dangerous radioactive material. James Bond even had a Geiger counter in his watch in the 1965 film Thunderball.

However, not all situations are suitable for humans equipped with handheld Geiger counters. For particularly dangerous scenarios, such as inspecting suspected weapons facilities or chasing down people who might be hiding explosives, authorities might choose to deploy a network of robotic drones carrying radiation-detecting sensors.

These sensors must be highly sensitive to distinguish small amounts of radioactive material from the background radiation ubiquitous in the environment from sources such as the sun and soil. The problem is that weak signals (or signals that have been made weak by consealment or shielding) are very quickly buried in the background noise as the distance between the material and the sensor increases.

"Robotic technology can help make more accurate decisions about whether something fishy is going on," said BERT TANNER, an associate professor of mechanical engineering at UD. "It's like looking for a needle in a haystack, so it all comes down to how sensitive and capable your detectors are and how smart your algorithms are."

The drones surround the target like a pack of lions scouting prey, but instead of attacking, they quickly collect and share information while on the move. Since each drone has a different path, what they "see" is slightly different. Some "speak" to and share data with more drones than others. Some are closer to the suspected source of radiation—so they collect more reliable measurements with higher signal and less noise. The question is—which drone has the best information to make the most accurate decision at the end? "We wanted to find out: How do we figure out which one should be the decision-maker?" says Tanner. "How can we make different drones compare notes?"

It is a classic dilemma of quality versus quantity—whether it is better to have a lot of information or a smaller amount of higher quality information. When you are dealing with radioactive material, decisions must be made in a matter of minutes, as delays could endanger lives.

Maybe one drone in the mix has sufficiently strong information and is also close enough to get quality information directly from the radiation source. Information flows through a network in both direct and circuitous paths. "This paper takes a first step toward characterizing those effects," said IOANNIS POULAKAKIS, an associate professor of mechanical engineering at UD.

The team did a series of calculations that brought together graph theory and principles of networking. Indrajeet Yadav, a graduate student in mechanical engineering, put pencil to paper after he realized that this problem had not been previously addressed. He also realized that some recently acquired mathematical skills could be useful.

"Just before this, I took a course on graph theory in the mathematics department," he said.

Yadav came to UD specifically to study with Tanner and Poulakakis. Yadav had been working in the nuclear industry for a few years before he decided to attend graduate school.

"Robotics is something I always wanted to do," he said.

The UD team did simulations and then tested their findings using field measurement data from a Domestic Nuclear Detection Office (DNDO) database with radiation sensor measurements. They found a formula that takes quantity and quality of observed radiation into account and decides which sensor is best placed to make the decision for the team.

Chetan Pahlajani, an assistant professor of mathematics at Indian Institute of Technology Gandhinagar, is also an author on the paper.

This work is supported in part by DTRA under award #HDTRA1-16-1-0039

https://doi.org/10.1007/s10514-018-9716-7

Buckley Receives Athletics Honor

Associate professor JENNI BUCKLEY was inducted into the UD Athletics Hall of Fame in 2017, making her the first-ever rower to receive this honor. A UD rower from 1999 to 2001, Buckley joined the squad during its second year of existence and was an immediate standout on the water for the Blue Hens. A native of Wilmington, Del., she was a member of the novice heavyweight eights boat in 2000 and led a crew that captured first place in every event it competed in during the spring, including the top finish at the prestigious Dad Vail Regatta where she helped lead the overall team to a runner-up finish. As a senior in 2001, she was named the team's UD Alumni Association Team Most Valuable Player as a member of the lightweight varsity eights crew that won the Dad Vail title and helped the team capture the overall regatta crown from among 150 schools. She earned her bachelor's degree in mechanical engineering at UD in 2001 and later earned her master's (2004) and doctorate (2006) degrees in mechanical engineering from the University of California, Berkeley. Buckley joined our faculty in 2011. She teaches a range of courses as part of the undergraduate curriculum and conducts research in biomechanics as well as engineering education, focusing particularly on issues of equity and inclusion.

Buchanan and Manal Receive Orthopaedic Research Society Award

THOMAS S. BUCHANAN, George W. Laird Professor of Mechanical Engineering, and KURT MANAL, research assistant professor, received the 2018 Journal of Orthopaedic Research® Excellence in Clinical Science Award for the paper "Gait Mechanics and Second ACL Rupture: Implications for Delaying Return-to-Sport." Published in the September 2017 issue of the journal, this paper reported the findings of a study to compare gait biomechanics and return-to-sport time frames in young female athletes who returned to sport after an ACL rupture. They found that, six months after primary reconstruction, athletes who sustained a second ACL injury after returning to sport received surgery sooner, had post-operative impairments resolved earlier, reached criterion-based return-to-sport benchmarks earlier, had higher body mass index and walked with lower peak knee flexor muscle forces bilaterally. They concluded that even for young women who feel fine and move well, it may be necessary to delay return to the field of play after primary ACL construction in order to reduce the risk of another injury. Other authors on the paper include: Jacob J. Capin, a doctoral student in biomechanics at UD; Ashutosh Khandha, an associate scientist at the Delaware Rehabilitation Institute; Ryan Zarzycki, a doctoral student in biomechanics and movement science at UD; and Lynn Snyder-Mackler, Alumni Distinguished Professor of Physical Therapy.

CANR ALUMNI HONORS

CANR recognizes recipients of Worrilow, Distinguished Alumni awards

JAMES L. GLANCEY was presented with the University of Delaware College of Agriculture and Natural Resources (CANR) George M. Worrilow Award in October 2017. The award is named for the dean of the college from 1954 to 1965, whose career was dedicated to better agriculture and better agricultural education.

It is given annually by the Ag Alumni Association to a graduate of the college who has exhibited outstanding service to agriculture.

Glancey is a professor with appointments in the College of Engineering and the College of Agriculture and Natural Resources. Glancey's work includes the development of new or improved products and automated processes, the forensics of product failures, as well as a better understanding of the underlying physics of many natural and manmade phenomena.

His research utilizes a combination of analysis and simulations, prototyping, and testing. Cooperation with several centers on campus is typical including the Center for Biomechanical Engineering Research and the Center for Composite Materials. Glancey and his students have co-authored more than 120 manuscripts since 1997 and several students have received national awards from the American Society of Mechanical Engineers (ASME) and the Society for the Advancement of Material and Processing Engineering (SAMPE).

TSU-WEI CHOU TAKES CENTER STAGE

At international conference, the UD mechanical engineering professor gave key lecture

IN THE FIELD OF COMPOSITE MATERIALS, TSU-WEI CHOU IS AN ICON.

CHOU, the Pierre S. du Pont Chair of Engineering, gave a plenary lecture in August 2017 at the 21st International Conference on Composite Materials (ICCM-21) in Xi'an, China.
More than 2,000 people from 45 countries attended the conference.
Chou's talk at the biennial conference, the world's largest conference on composites, recounted his personal journey in the field. For more than five decades, which includes 49 years at UD, Chou has studied composite materials.
When Chou began his career, scientists largely worked on structural composites, such as particulate-reinforced polymeric, ceramic, and metal matrix composites. Now, researchers aim to optimize the functionality of composites, often using nanoscience.
For example, researchers worldwide are looking to embed airplanes with carbon nanotubes or graphene. The conductivity of these materials might allow a plane to de-ice itself or repair itself if its exterior sustains damage.

"We used to do work in meters, centimeters, and millimeters," he said. "Now we can extend it to the nanoscale."

Chou himself has published hundreds of papers on composites. Much of his current work focuses on carbon nanotube and graphene fibers and films.
Researchers are constantly discovering new applications for composite materials, and this is exciting—but also challenging.
"To be able to take advantage of the opportunities, I myself have to change," he said. "I must learn new things all the time."
Chou learns with his students as they conduct research. He consults with other colleagues. During his career, he has even sat in on classes in other departments in order to expand his knowledge base. In his talk at ICCM-21, he emphasized the importance of personal renewal.

JACK GILLESPIE, Director of the Center for Composite Materials, said: "Dr. Chou is one of the founders and intellectual leaders of the center. His life-long achievements and dedication to academic excellence has established the standard that we all strive to achieve as faculty and mentors. Over the past four decades, I've witnessed firsthand Dr. Chou's extraordinary ability to launch new research initiatives from microstructure-property relationships in short fiber composites, textile composites, ceramic matrix composites and more recently multi-functional nanocomposites. In all cases, he has emerged as an international expert in each of these fields and has been highly recognized by his peers with numerous prestigious international awards that are so very well deserved".

Chou has received numerous accolades over his career. He is a Fellow of AME, ASM, ASC, ACerS, TMS and AIAA. He is the editor-in-chief of the journal Composites Science and Technology and won the 2017 Albert Sauveur Achievement Award of ASM International.

PROFESSOR GILLESPIE HONORED BY SOCIETY OF PLASTICS ENGINEERS

Gillespie is director of UD's world-renowned Center for Composite Materials

The University of Delaware's JOHN W. (JACK) GILLESPIE JR. has been named a Fellow of the Society of Plastics Engineers (SPE). Since 1984, just 334 of the society's 22,500-plus members have achieved Fellow status.

To be named an SPE Fellow, one must make outstanding achievements in plastics engineering, science or technology or in the management of such activities. Fellows are selected for accomplishments that have advanced the plastics industry, through publications, patents and management of groups that have made technological advances.

Gillespie has been doing all of that for decades. He is the director of UD's world-renowned Center for Composite Materials (CCM), a position he has held since 1996. Under his leadership, CCM doubled in size to a center with 58,000 square feet of laboratory space housed in two facilities with more than $25 million in equipment, including a Composites Manufacturing Science Laboratory and an Application and Technology Transfer Laboratory. In 2017 alone, more than 150 researchers were involved in CCM activities.

Gillespie's career at UD has included a steady stream of accomplishments, such as the creation and commercialization of new processes, automated equipment, materials and composite structures. He is an author on 835 publications in composites science and technology, which includes 19 books and book chapters, 21 patents, 320 refereed journal papers and 475 proceedings papers many co-authored with more than 95 graduate students he has advised. He has an h-index of 59, i10-index of 297 and more than 14,000 citations on Google Scholar as of February 2018.

To support his research and CCM activities, Gillespie has received more than $190 million from industry and government resources. For example, Gillespie is UD's principal investigator on an Army Research Lab Cooperative Research Alliance to develop composite materials that can hold up under extreme dynamic environments, which is part of a 10-year basic research consortia renewed through 2022. He is also the Donald C. Phillips Professor of Civil and Environmental Engineering with appointments in the departments of Materials Science and Engineering and Mechanical Engineering.

"I have closely followed Jack's career for more than three decades, and his widespread influence in plastics engineering can not be understated," said J. Michael Bowman, the state director of the Delaware Small Business Development Center and the associate director of UD's Office of Economic Innovation and Partnerships. "He developed technologies that have improved the performance of a broad range of products, from airplanes to automotive to orthotics and bridges. Through his leadership at CCM, he also trains the next generation of innovators so that they can push the field even further than any one person could alone."

Outside UD, Gillespie has served as a member of the National Research Council on Manufacturing and Engineering Design and as chair of the National Materials Advisory Board Committee on High-Performance Structural Fibers for Advanced Polymer-Matrix Composites. He has been editor of the Journal of Thermoplastic Composite Materials since 1993, and he serves on numerous editorial boards.

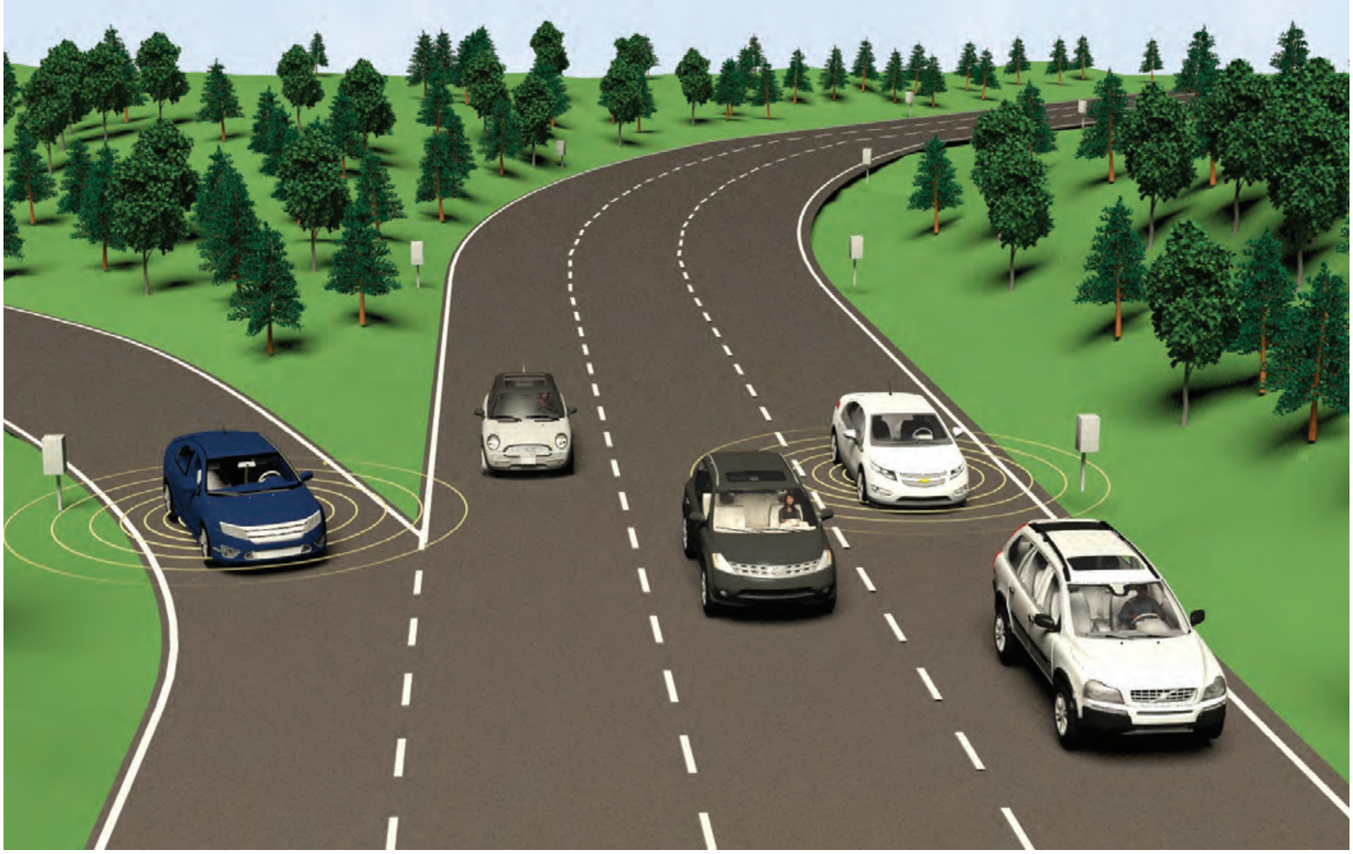
He has received numerous awards, including the American Society of Civil Engineers Charles Pankow Award for Innovation for commercializing composite bridge structures.

He is also a fellow of the Society of Manufacturing Engineers (SME), the American Society for Composites (ASC) and the Society for the Advancement of Material and Process Engineering (SAMPE).

Gillespie has been a member of SPE since 1990 and now serves on the board of directors of SPE's Composites Division. He is also a member and past-president of SPE's Joining of Plastics and Composites Special Interest Group.

– ANDREAS MALIKOPOULOS ON –

CONNECTED AND AUTOMATED VEHICLES



In UD labs, Malikopoulos tests fuel-efficient connected and automated vehicles

Vehicles of the future are being put to the test at UD. ANDREAS MALIKOPOULOS is researching ways to maximize fuel efficiency in a connected and automated vehicle (CAV), which uses sensors, cameras and advanced control algorithms to adjust to changing conditions with minimal or no driver input. Malikopoulos develops and implements control technologies to allow vehicles to bypass roadblocks, change speed based on traffic conditions and adjust their powertrains to optimize efficiency.

He is the principal investigator of a $4.2 million, three-year project funded by the Advanced Research Projects Agency for Energy (ARPA-E) through its NEXT-Generation Energy Technologies for Connected and Automated On-Road Vehicles (NEXTCAR) program to improve the efficiency of an Audi A3 e-tron by at least 20 percent. The partners of this project are the University of Michigan, Boston University, Bosch Corporation and Oak Ridge National Laboratory. For this project, Malikopoulos established a facility equipped with six driving simulators that can represent human-driven vehicles linked together in a transportation environment. This environment can include CAVs at any desired penetration so that the interaction between CAVs and human-driven vehicles can be studied.

"Andreas is doing research that could help to shape the future of transportation," said Ajay Prasad, department chair. "UD mechanical engineers have a long history of innovation in safe, energy-efficient, zero-emission transportation, and Andreas is adding a new and important layer to our base of expertise. "

Malikopoulos also built a second laboratory, a small-scale (1:24) "smart" city that covers an area of 20 x 20 feet with about 35 robotic cars to replicate real-world traffic scenarios in a small, controlled environment. Smart cities are designed to optimize energy and safety, and CAVs can help toward establishing energy efficient mobility systems. These vehicles convey information to each other in order to keep drivers, passengers and pedestrians safe while delivering everyone to their destinations on time. In UD's Scaled Smart City, Malikopoulos tests new vehicle technologies on miniature models, without the costs and safety concerns that full-size vehicle tests would bring. The work in this testbed complements the results from the driving simulators. Malikopoulos and his students can use the simulators to develop algorithms and then use the miniature city's hardware to test those algorithms. That helps him optimize the whole system.

PROFESSOR MALIKOPOULOS ELECTED ASME FELLOW

Fewer than 3 percent of society members earn this status

Associate professor ANDREAS MALIKOPOULOS has been elected Fellow of the American Society of Mechanical Engineers (ASME). While ASME has more than 130,000 members worldwide, fewer than 3,500 are Fellows. This distinction is only available to scholars with 10 years of ASME membership who have sustained significant engineering achievements. "I am delighted, honored and humbled to be elected to the grade of ASME Fellow," said Malikopoulos. "I would like to thank Prof. Tsu-Wei Chou for the nomination."

In his nomination letter, TSU-WEI CHOU, Unidel Pierre S. du Pont Chair, noted that Malikopoulos is internationally recognized for his work in analysis, optimization, and control of powertrain systems; decentralized control for cyber-physical systems; and learning in complex systems. He praised Malikopoulos for his recently developed decentralized optimal control framework for connected and automated vehicles, which allows vehicles to pass through intersections safely and efficiently, no traffic lights required.

"Dr. Malikopoulos' approach has the potential to revolutionize our transportation system and transform it into an energy efficient mobility system," wrote Chou, who became an ASME Fellow in 1998.

Malikopoulos joined the UD faculty in 2017. He recently established two laboratory spaces—a virtual reality lab to develop concepts for connected and automated vehicles and scaled smart city to test those concepts. Malikopoulos was also recently promoted to Senior Member of IEEE, a status conferred upon fewer than 9 percent of the organization's members. Before he joined UD, Malikopoulos was the deputy director and the lead of the Sustainable Mobility Theme of the Urban Dynamics Institute at Oak Ridge National Laboratory and a senior researcher at General Motors Research & Development. Malikopoulos earned his doctoral degree in mechanical engineering from the University of Michigan, Ann Arbor.

PROFESSOR FESER RECEIVES UDRF AWARD

Awards provide traction for promising research

Professor JOSEPH FESER is one of five University of Delaware professors who won support for promising early-phase research projects in widely diverse areas. The new awards from the University of Delaware Research Foundation give researchers traction in the early stages of projects that support the strategic initiatives of the University, allowing them to develop ideas and build a stronger foundation for future studies.

Innovators are developing and working with many new materials and re-engineering others to produce new capacities and functions in technology. Joseph Feser, assistant professor of mechanical engineering, is studying the thermal conductivity of two-dimensional layered materials known as hybrid perovskites. He will team with Prof. CHAOYING NI in the work.

Hybrid perovskites have unique properties that make them attractive for use in photovoltaics, lasers and solar-fuel production, but their ability to conduct heat is not yet understood.

Feser will characterize these properties, establish whether they are extreme thermal insulators, explore how thermal transport is accomplished and test the hypothesis that interlayer bonding may increase thermal conductivity in next-generation materials.

Invited Keynote Presentation at EPD 2017 in South Korea

Associate professor ERIK THOSTENSON gave a keynote lecture “Nanotube/Fiber Multi-Scale Hybrid Composites using Electrophoretic Deposition” at the sixth International Conference on Electrophoretic Deposition (EPD 2017) held on Oct. 1-6, 2017 in Gyeongju, South Korea. The conference, which is held every three years, brings together experts across the world working in the area of electrophoretic deposition (EPD) with focus on its application as a processing technique for the manufacture of new materials and composites. Thostenson, who is also affiliated faculty with the Department of Materials Science and Engineering and the Center for Composite Materials, received his NSF CAREER award to study the EPD process as an industrially scalable approach to create novel hybrid carbon nanotube/fiber composites. “The EPD approach established by my group has enabled us to explore future applications of these materials, ranging from sensors for structural health monitoring of infrastructure to the development of smart textiles,” Thostenson said.

> *“The EPD approach established by my group has enabled us to explore future applications of these materials.”*

Joe Kuehl was selected to serve on the NAS committee on the Gulf of Mexico Loop Current

Tom Buchanan was selected to serve on the NIH Musculoskeletal Rehabilitation Sciences Study Section

Bert Tanner was selected as the 2018 Outstanding Junior Faculty Member for the College of Engineering

JENNI BUCKLEY was named to the American Society for Engineering Education's "20 Under 40." In nominating her for the honor, department chair Ajay Prasad said: "Dr. Buckley has been on our department's faculty for the past six years, and during this time, she has single-handedly transformed our undergraduate curriculum." She leads the department's senior design program, attracted industry funding for the state-of-the-art Design Studio, and more. "In my 25 years in this department, I have never seen our students as energized, enthusiastic and motivated," said Prasad.

Jenni Buckley was selected as the recipient of the 2018 Dean's Award for Excellence in Service and Community Engagement Award

MEET OUR FACULTY

JOSEPH KUEHL

JOSEPH KUEHL joined the mechanical engineering department as an assistant professor in 2017. He was previously an assistant professor of mechanical engineering at Baylor University. He earned doctoral degrees in mechanical engineering and physical oceanography from the University of Rhode Island. His research interests include hypersonic boundary-layer stability, nonlinear vibrations and geophysical fluid dynamics.

He received an AFOSR Young Investigator Award in 2015 for his hypersonic boundary layer stability and transition research, is a member of the National Academy of Science Committee on Advancing Understanding of the Gulf of Mexico Loop Current Dynamics and is a member of the NATO STO AVT-240 working group on Hypersonic Boundary-Layer Prediction.

At UD, Kuehl looks forward to expanding his hypersonic stability and transition research, establishing a geophysical fluid dynamics laboratory and collaborating with colleagues in the College of Engineering; College of Earth, Ocean, and Environment, and the Department of Mathematical Sciences.

THOMAS BUCHANAN

THOMAS BUCHANAN is director of the Delaware Rehabilitation Institute, and he leads the NIH Center of Biomedical Research Excellence (COBRE) on Osteoarthritis Prevention and Treatment at the University of Delaware. He is also coordinator of the Delaware Clinical and Translational Research ACCEL program, an NIH-sponsored strategic partnership with Christiana Care Health System, Nemours and the Medical University of South Carolina.

He has led NIH research grants continuously since 1990—his work primarily addressing neuromuscular and musculoskeletal problems, such as arthritis, stroke and sports medicine problems. His research involves biomechanics, medical imaging and neuroscience. As an engineer, he uses computer models to characterize and quantify healthy and pathological tissue, and he models the forces in the human body that can lead to injuries or long-term damage.

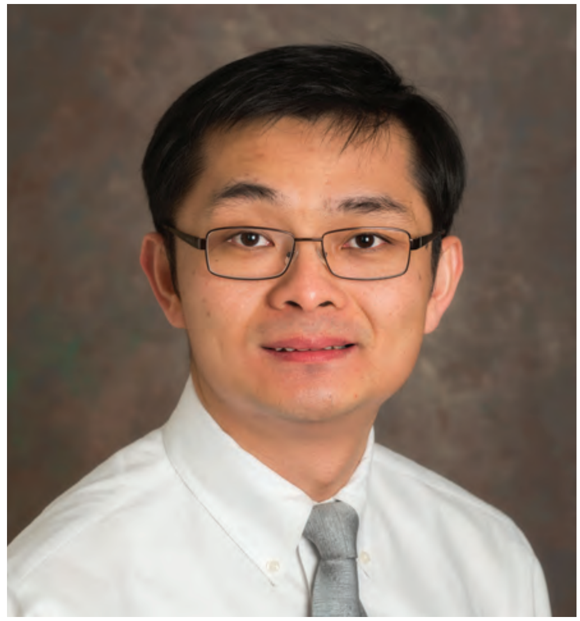
Buchanan's research is focused on developing a better understanding of how muscles compensate for injury or disease. Research interests include knee stability and osteoarthritis, medical imaging and models of muscle coordination.

JILL HIGGINSON

JILL HIGGINSON leads research aimed at improving understanding of muscle coordination for normal and pathological movements through coupled experimental and simulation studies. Higginson's group uses state-of-the-art modeling and optimization techniques to develop a cause-and-effect framework that relates muscle impairments to gait deviations. Experiments involve three-dimensional kinematic and kinetic analysis and electromyography (EMG) recording during treadmill and overground gait. Modeling and optimization are used to develop simulations based on experimental data.

Ongoing research projects are related to muscle deficits and subject-specific interventions for post-stroke hemiparetic gait, simulation-based analysis of muscle coordination in healthy and pathological gait, and interactions between cognitive function and gait performance. Recent papers have focused on measurements of propulsion and dynamic structure of lower limb joint angles during walking post-stroke.

The overarching goal of the work is to form a scientific rationale for therapeutic interventions to improve movement. Higginson is also co-PI with X. Lucas Lu on an NSF program to provide a biomechanics research experience for undergraduate students on the UD campus each summer.



X. LUCAS LU

X. LUCAS LU and his collaborators are addressing several bioengineering problems. The first is prevention of post-trauma osteoarthritis. Although arthritis is generally associated with aging, it can also result from the type of trauma experienced by young soldiers and athletes. With support from the Department of Defense, Lu has teamed with surgeons and biologists to study the effectiveness of statins in the treatment and prevention of osteoarthritis. Statins are FDA-approved and prescribed to hundreds of millions of people in the US for cholesterol control. Lu's group is also performing a big data study to analyze the statin use and osteoarthritis occurrence in the Delaware population.

He is also investigating the mechanics and lubrication of the temporomandibular joint (TMJ). Using novel mechanical technology and finite element simulation, Lu is studying the structure-function correlation of the cartilaginous tissues in the TMJ and its lubrication mechanism. He is also working with a team of oral surgeons to investigate the use of natural polyphenols for the treatment of TMJ disorders.

Another area of interest for Lu is rehabilitation for microfracture surgery to repair cartilage lesions. Young athletes suffering from trauma-induced cartilage loss are often treated with microfracture surgery, a minimally invasive procedure that creates tiny punctures in the bone to stimulate bone marrow growth in the damaged area. Lu is working with physical therapists and orthopedic surgeons to optimize the rehabilitation protocol after surgery and to enhance the deposition and quality of newly repaired tissue at the injury site.

IOANNIS POULAKAKIS

IOANNIS POULAKAKIS' research interests are in the area of dynamics and control with application to bio-inspired robotic systems, specifically legged robots. He is also interested in problems related to the dynamics of collective decision making in multiagent systems.

Supported by a prestigious Faculty Early Career Development Award from the National Science Foundation, Poulakakis is investigating ways to regulate the cyclic motion of legged robots so they can perform tasks such as surveillance or exploration, jobs previously reserved for wheeled systems.

Poulakakis and his team are focused on providing the necessary robotics science and technology to create dexterous, highly mobile legged robots that can autonomously plan actions in human-centric environments. They are working to develop real-time planning algorithms that can bridge the gap between a robot's platform controls and higher-level motion planning objectives.

If successful, this research will bring highly mobile and versatile robot platforms like legged machines closer to real-life applications in industry, agriculture and emergency response. For example, in supply chain management systems, legged robots could help companies rapidly reconfigure their production or assembly lines to adapt to changes in demand or new product designs.

Similar to their counterparts in nature, small- and large-legged robots operate differently. The researchers are working with robots of different types and sizes so they can study the effect of scale on their approach.

MICHAEL SANTARE

MICHAEL SANTARE joined the UD faculty in 1986. He was a founding member of UD's Orthopedic and Biomechanical Engineering Center (now called the Center for Biomechanical Engineering Research) and served as its director from 1993 to 1998 and again from 2014 to 2017. He was also a founding faculty member of the nationally ranked interdisciplinary Biomechanics and Movement Science graduate program at the University.

Santare's research focuses on the mechanics of materials and structures. He combines analytical and experimental studies to understand and predict the relationships among microstructure, mechanical response and material failure, with specific applications in the areas of fuel cells materials, composite and functionally graded materials and orthopedic biomechanics.

His most recent publications have focused on mechanics of soft tissue damage and characteristics of polymer electrolyte membranes for fuel cell applications. He is a member of the mechanical engineering department's Center for Fuel Cells and Batteries. Santare is a Fellow of the American Society of Mechanical Engineers and consults with private companies and law firms in addition to his academic research.

NEW LEADER OF CENTER FOR BIOMECHANICAL ENGINEERING RESEARCH

Mechanical Engineering Professor Liyun Wang is the sixth director of UD's CBER

LIYUN WANG, a professor of mechanical engineering, has been named director of the University of Delaware Center for Biomechanical Engineering Research (CBER), a research center that develops engineering science and clinical technology to reduce the impact of diseases like osteoarthritis, osteoporosis, degenerated discs and cystic fibrosis on people.

"I am excited about the future prospects for the center under the leadership of Dr. Wang," said prior CBER director and founding member Michael Santare, a professor of mechanical engineering. "Liyun has the energy and vision to keep CBER relevant and moving in the right direction." Researchers at CBER are studying how bone, cartilage and ligaments respond to stress and strain; testing new compounds and biomaterials to prevent and treat osteoarthritis after traumatic injury; developing methods to help stroke and other motor-impaired patients walk again; and exploring the cellular mechanisms to promote tissue engineering.

WANG'S VISION TO EXPAND ON CBER'S PRINCIPLES

Since its founding in 1990, CBER has been interdisciplinary, bringing together faculty members in mechanical engineering, physical therapy, biological sciences, material sciences and engineering, kinesiology and applied physiology and biomedical engineering who also collaborate with local hospitals and clinical facilities.

These collaborations have led to many successful grants focused on research or student training. One example is the $30 million Center for Biomedical Research Excellence (COBRE) on Osteoarthritis Prevention and Treatment led by Thomas Buchanan (CBER director from 1998 to 2004) over the past 15 years.

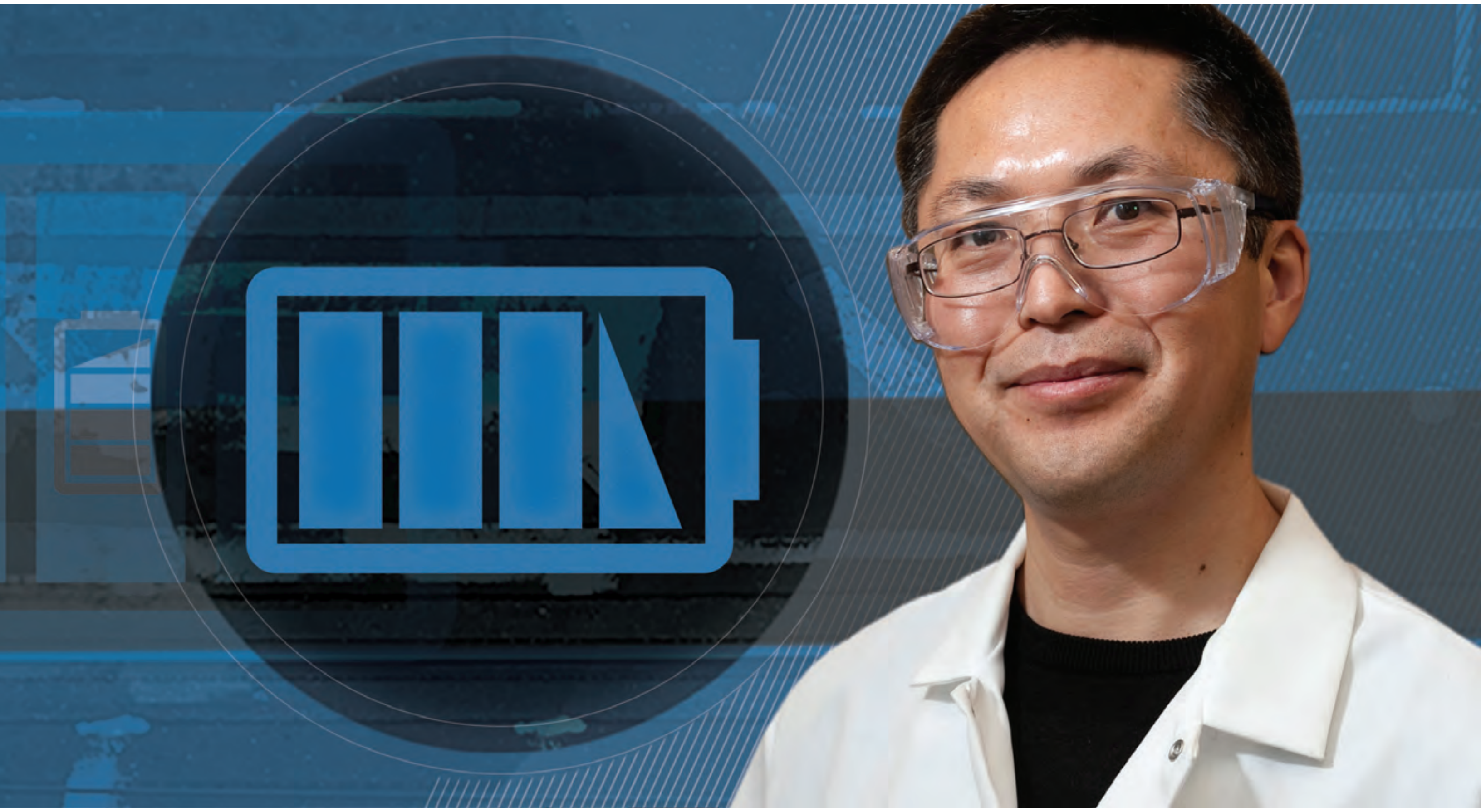
Wang, who has been on the faculty at UD since 2005, hopes to continue a culture of interdisciplinary collaboration and facilitate the collective efforts of CBER faculty in pursuing large research proposals and training grants.

"We have a critical mass of faculty who are performing exciting biomechanics research across our campus," she said. "CBER will serve as a hub for exchange of ideas and an incubator for cultivating the collaborative work."

CBER also has a successful history of student research, including the NSF Research Experience for Undergraduates (REU) led by Jill Higginson (CBER Director from 2008 to 2014). For the past two summers, approximately twenty REU and CBER Summer Scholars participated in an intensive ten-week research, workshops, and social events.

"Training the next generation of scientists is what higher education is about," said Wang. "CBER will continue to support the REUs for undergraduates. We will fund six more undergraduate summer scholars in CBER through the Vincent Baro fellowship provided by the Stanley Family Foundation. Meanwhile, we will explore mechanisms to support graduate student training."

CBER also hosts a yearly research symposium and works with entrepreneurs to design and develop new technologies.



FUELS OF THE FUTURE

Under its new moniker, UD's Center for Fuel Cells and Batteries will be a hub of energy innovation

Alternative fuels will power our future—and that future is coming fast. Earlier this month, General Motors announced that it plans to launch at least 20 all-electric vehicles by 2023.

At the University of Delaware, the Center for Fuel Cells and Batteries, formerly known as the Center for Fuel Cell Research, is a hub for innovation in sustainable fuel.

BINGQING WEI, professor of mechanical engineering, is the new director of the Center for Fuel Cells and Batteries. An expert in electrochemical batteries and capacitors, he will lead the center as it explores a wider range of technologies for clean, efficient energy.

"The center was previously focused mostly on fundamentals of fuel cell technology," he said. "In the past eight years, there has been increased focus on batteries as well."

The Center for Fuel Cells and Batteries brings together a range of experts with backgrounds in mechanical engineering, chemical and biomolecular engineering, civil and environmental engineering, materials science and engineering and electrical and computer engineering.

"Our center serves as a platform to focus on fundamentals and apply them to make new technologies," said Wei.

Researchers with the Center for Fuel Cells and Batteries are driving innovation in areas such as supercapacitors, stretchable electronics, novel fuel cell membranes and fuel cell system modeling and simulation.

"We are the leader in developing new concepts," said Wei.

SEEKING EQUALITY IN ENGINEERING

Over the past 15 years, the University of Delaware's College of Engineering has tripled its proportion of women faculty. The college's faculty and deans over the last 15 years have played critical roles in this effort and in the work of UD ADVANCE. Through funding from the National Science Foundation, UD ADVANCE has worked to recruit and retain an increasingly diverse pool of talented faculty to UD.

HEATHER DOTY, an assistant professor in the Department of Mechanical Engineering and a co-principal investigator of UD ADVANCE, has played an important role in this effort. Although there is more work to do, we have made substantial improvements.

A FEW HIGHLIGHTS:

- We have more female faculty members. In 2003, only 7 percent of the tenured/tenure-track faculty in UD's College of Engineering were women. Now, women make up 21 percent of the full-time engineering faculty. Nationwide, about 16 percent of university engineering faculty are women, according to the American Society for Engineering Education.

- We have more women in leadership roles. Of the seven academic departments in UD's College of Engineering, three are chaired by women. That's the most in the history of the college. The dean's cabinet now includes two female associate deans and a female deputy dean.

- More women are receiving named professorships. Fifteen years ago, all of the named professors and junior named professors in the College of Engineering were men. Now, four of our named professors and three of our junior named professors are women.

- We are bringing more female engineering leaders to visit our campus. The Richard and Janet Haines endowment to the Women in Engineering program has allowed us to substantially enhance our programmatic offerings. For example, we can now offer travel and lodging to engineers from around the country for our career panels. This allows us to bring in professionals from more disciplines and a greater diversity of companies.

- We are making progress in terms of the number of undergraduate women in some departments, such as mechanical engineering. This department awarded 17.6 percent of its bachelor's degrees to women in the 2016-2017 school year, exceeding the national average of 13.8 percent. This fall, female students made up 20.8 percent of mechanical engineering students at UD.

FOR MORE, VISIT WWW.UDEL.EDU/004796

FROM THE UD RESEARCH MAGAZINE

Suit me up for Mars!

As soon as Neil Armstrong took that one small step and put his size-9-1/2 foot on the surface of the moon in 1969, people started asking: When will the first Marswalk be? If reaching the moon was a "giant leap," as Armstrong said it was, getting to Mars is at least two orders of magnitude beyond. You could look at it this way: If you were the world's best "giant leap" guy—world record holder Mike Powell, say—you'd have to go from jumping 29 feet, 4 1/2 inches (just short of a first down) to jumping 5 1/2 miles (more than 96 football fields).

Getting to Mars is an enormous challenge—and survival after arrival? No human being can survive real-life conditions on Mars without extraordinary protection and support. So before anyone starts packing for such a trip, an essential question must be raised and resolved: What do you wear on Mars?

ILC Dover should know. The Delaware firm has been outfitting NASA astronauts—including Armstrong—since the Apollo Mission. And when this contract to build the next generation Z-2 spacesuit arrived from NASA, ILC tapped into the state-of-the-art technology, science and mathematics available at the University of Delaware's Center for Composite Materials (CCM). There, they have access to the expertise of professors, researchers, a team with extensive experience in aerospace, industry and manufacturing and a facility that meets NASA's security requirements.

"We were very impressed with UD's CCM lab and the fact that you've got University personnel who have strong industrial and manufacturing experience," said STEPHEN SCARBOROUGH, ILC Dover's research and development engineering manager who earned his BCEE'99 and MS'07 at UD. "You have this combination of professors and researchers who are able to perform amazing analysis with impact and composite properties—modeling and manufacturing and material selection all at one facility."

CCM—with its broad range of capacity and decades of experience—was indeed a good match. "The level of precision, the modeling, the manufacturing—that could only be done with the full capabilities of the center, the right people with the right skills," said JACK GILLESPIE, director of CCM since 1996 and the architect of a university-industry consortium that now includes more than 50 partners.

On Mars, the suit must protect the astronaut from radiation, sharply reduced atmospheric pressure, extreme temperature changes, falls, micrometeoroids, dust storms and other planetary perils. NASA's requirements for this training suit were rigorous. Following NASA specifications and using new computer models and simulations developed at UD, CCM delivered new components for ILC Dover that make the Z-2 suitable for landings on the moon and Mars. That's something like taking just one outfit on a vacation that goes from a lake of burning sulfur to a cryogenics lab. You don't get clothes like that off the rack.

One major problem went to Bazle "Gama" Haque, senior scientist and assistant professor of mechanical

High-level calculation, design and manufacturing processes went into development of components for ILC Dover's Z-2 spacesuit project. Among those on the team were (from left) Jason Etherington, Dan Molligan, Rennie Burris, Bazle "Gama" Haque and Jack Gillespie engineering, who figured out how to calculate the impact the suit must tolerate if the astronaut fell down on the moon or on Mars. How fast would the astronaut fall? What would happen if the astronaut fell onto a sharp rock? What if the impact was on the astronaut's chest? Hips? Back?

"That is a great computational challenge," Haque said.

Defending the astronaut against micrometeoroids that might arrive at speeds greater than 2,237 miles an hour was another high-level problem to address. Using state-of-the-art MAT162 software, Haque was able to calculate and show the kind of damage that would occur in a range of scenarios, and the team came up with a composite material and a process that would perform in every situation.

With Haque's precise analysis, ILC, UD and NASA chose a hybrid structure of carbon and glass in a matrix of epoxy that David Graziosi, ILC principal engineer, calls "the most advanced composite structure ever deployed in space" for the Z-2's Hard Upper Torso (HUT). The HUT is a fiberglass-strengthened shell that protects the body and also bears the weight of a life-support system, communication devices and attachments for tethers and assorted connections.

The project unfolded over a three-year period, as ILC and UD experts explored material options, worked on designs, determined necessary stiffness and tensile strength of materials, tested the load they could bear and the strain they could withstand, figured out how they should fit together and how they would react to sometimes-extreme changes in temperature and pressure. They designed tools and processes to produce what was needed.

They met with many challenges, as you might expect.

For example, wrapping a flat fabric around a cylinder is not usually a problem, said Dan Molligan, CCM assistant director for application development. Wrapping it around a sphere requires shearing —a definite complication.

There are no flat spaces on the torso piece, he said, and that makes it more difficult to lay out the materials, especially in areas where the carbon fiber epoxy material goes from thin to thick. The thickness can range from an eighth of an inch to 2 inches in some places. The material in the Z-2—carbon fiber with 1 million pounds per square inch of tensile strength—is impregnated with resin and cut to precise specifications using a computer-controlled ply cutter. The pieces are then positioned using a laser system that projects the patterns— hundreds of unique patterns were involved—onto the Z-2 part tool. A layer of S-glass is incorporated to increase impact resistance.

The Z-2 was subjected to months of rigorous testing at NASA's Neutral Buoyancy Lab near the Johnson Space Center in Houston. There, astronauts were submerged in a giant tank filled with a million gallons of water, in which they practiced the maneuvers they will perform in space and put the suit through its paces. Testing continued into last summer, and as materials and designs are evaluated, NASA will make decisions about the next step for the Mars spacesuit.

"Sending a human to Mars will answer some of the major questions that humanity has," Scarborough said. "Is there life there? Is life on our planet the only place in the universe or the solar system where it exists? And being able to put a human there instead of a robot allows the research to happen so much faster."

As with so many NASA-led developments, the technological advances and innovations that are part of this mission are likely to have applications in many other areas.

"The idea of hybrid carbon-glass composites can have application in high-performance vehicles," Scarborough said, "potentially with impact resistance and military-type impact performance. Some things developed for the military are now being qualified to be used in space."

And the Z-2 has performed well.

"There have been no issues with the suit and nothing with the composite structure, which is really good on a prototype like this," Graziosi said. "They're hanging simple things—mockup life support systems—but those are a lot of stressing interfaces to the hatch and the HUT, while the crew goes into the water to do things.

"They have had zero issues, zero leakage, zero structural problems. And that's a really big deal."

"They have had zero issues, zero leakage, zero structural problems.

And that's a really big deal."

Design Studio highlighted in EdTech Magazine

Our Design Studio was highlighted in EdTech Magazine in July 2017 as an example of a makerspace that teaches 21st-century skills. Our Design Studio has everything from digital fabrication equipment to complex testing rigs, and it's built for students to make mistakes and iterate using the design process. In 80 percent of our courses, students use the makerspace to get hands-on experience.

ENGINEERING ENTREPRENEURSHIP

Summer program supports entrepreneurial mindset

In collaboration with the Horn Program in Entrepreneurship, the University of Delaware College of Engineering (CoE) is running a program called CoE Fellows in parallel with the Summer Founders program offered by Horn.

The program was launched in summer 2017 with the support of DAVID WELCH, an alumnus of UD's Department of Electrical and Computer Engineering.

Vince DiFelice, venture support lead at Horn Entrepreneurship, refers to the program as one part startup and one part summer job — providing mentorship resources to promote startup success and allowing students to work full time over the summer on their business concepts unencumbered by the demands of the academic year.

While the CoE Fellows program in summer 2016 started with just four students on two teams, it was expanded to 12 students on four teams in the summer of 2017.

2017 2018 | DISTINGUISHED *SEMINAR SERIES*

FALL 2017

Roberto Horowitz
Chair, Department of Mechanical Engineering James Fife Endowed Chair Professor of Mechanical Engineering University of California, Berkeley
September 22, 2017
Modeling, Control and Estimation of Freeway Traffic Networks

NOWINSKI SEMINAR:
Kon-Well Wang
Stephen P. Timoshenko
Professor and Tim Manganello/BorgWarner Department Chair Department of Mechanical Engineering University of Michigan
October 20, 2017
From Muscles to Plants – Nature-Inspired Adaptive Metastructures

Allen Robinson
Department Head and Raymond J. Lane Distinguished Professor Mechanical Engineering Carnegie Mellon University
November 17, 2017
Title: The shale gas revolution: green energy or a bridge to nowhere?

Elizabeth Hsiao-Wecksler
Associate Head for Undergraduate Programs, Professor, Willett Scholar University of Illinois at Urbana-Champaign
December 1, 2017
Bio-mechatronics: Using Technology to Improve Human Movement

SPRING 2018

Ilya Kolmanovsky
Professor of Aerospace Engineering University of Michigan
February 23, 2018
Drift Counteraction Optimal Control: Theory, Computations and Applications

Scott L. Diamond, PhD
Professor, Department of Chemical and Biomolecular Engineering Institute for Medicine and Engineering University of Pennsylvania
March 2, 2018
Multiscale Analysis of Blood Using Microfluidics and High Dimensional Phenotyping

JACK R. VINSON SEMINAR:
Alexandre M. Bayen
Liao-Cho Innovation Endowed Chair Director of the Institute of Transportation Studies University of California Berkeley
April 6, 2018
Inference and Control in Routing Games

Markus J. Buehler
McAfee Professor of Engineering Department of Civil and Environmental Engineering Laboratory for Atomistic & Molecular Mechanics Massachusetts Institute of Technology
May 11, 2018
Multiscale Smart Materials by Design - Connecting Simulation, Design, Synthesis Across Multiple Scales

JERZY L. NOWINSKI DISTINGUISHED LECTURE

The Nowinski Lecture Series honors the late Jerzy L. Nowinski, Professor Emeritus in Mechanical Engineering at the University of Delaware, for his contributions to the field of Applied Mechanics. Each year, one outstanding individual in Applied Mechanics is invited to present a lecture in the series. Dr. Nowinski was the H. Fletcher Brown Professor in the Department of Mechanical Engineering and subsequently the Department of Mechanical and Aerospace Engineering at the University of Delaware from 1961 to 1973.

JACK R. VINSON DISTINGUISHED LECTURE

The Vinson Lecture honors Jack R. Vinson, the H. Fletcher Brown Professor Emeritus of Mechanical and Aerospace Engineering at the University of Delaware. Vinson, who joined the UD faculty in 1964 and taught one of the first composites courses in the US in 1969, was the founding director of the University's Center for Composite Materials in 1974. He served as chairmain of UD's Department of Mechanical and Aerospace Engineering from 1965 to 1979.

STUDENTS OF INNOVATION

Our students are making next-generation products

When a Maryland-based boat kit company wanted help designing a component that rowers sit in, they contacted a University of Delaware engineer with ideal expertise. JENNI BUCKLEY, an associate professor of mechanical engineering and a rower in the UD Athletics Hall of Fame, advises students in Senior Design, a one-semester capstone engineering design program.

A four-student team advised by Buckley developed a new sliding seat rigger unit, made largely of aluminum, for Chesapeake Light Craft. In December 2017, the team, which includes two members of the UD men's rowing club team, presented their design to their sponsor and a panel of evaluators, alumni, and visitors. The team touted their prototype's strengths, such as its originality, compatibility with the boat, flexion, and weight.

"It exceeds my expectations a great deal," said John Harris, CEO of Chesapeake Light Craft, from the audience. With minimal tweaks, this device could likely deliver ideal performance at a reasonable price.

"I'm very excited. I can't wait to get it in the water," he said.

CELEBRATING SENIOR DESIGN

The mechanical engineering and biomedical engineering departments collaborate on this semester-long course. Every senior in these two departments participates, and students in other departments can choose to join as well.

This boat part was just one of 40 projects UD student groups presented at the Senior Engineering Design Celebration on Dec. 13, 2017 in Clayton Hall. More than 200 participants and 300 audience members attended.

Student teams are asked to solve real-world problems that could help sponsors improve their businesses or make new products. The projects covered a broad range of subjects. For example, one team designed a wearable birthing simulator with a novel fluid release mechanism, which can be used to help train healthcare workers who deliver babies. Another worked to improve 3D printing of concrete. One team was tasked with developing a free-standing electric vehicle charging unit. Another developed a bike pedal for people recovering from anterior cruciate ligament (ACL) injuries.

Students develop prototypes utilizing the Mechanical Engineering Design Studio, a 24/7, open-access makerspace to design, fabricate and test ideas. They are bound by industry standards and budgetary constraints.

"We had another fantastic year for Senior Engineering Design, with upwards of 40 industry, academic, and community partners," said Buckley. "Every year, the quality of what our students produce as final designs keeps going up and up. This is the first class of mechanical and biomedical engineering students who have grown up in our design studio all four years in the program. Design is just second nature for them."

Some Senior Design teams develop prototypes on the threshold of commercialization, and several projects have yielded company-sponsored patent applications in the program's history.

This experience influences UD engineers beyond graduation.

"The greatest evidence of this course's success is the high volume of positive reviews and enthusiastic feedback we receive from alumni who have achieved success in industry," said Ajay Prasad, chair of the Department of Mechanical Engineering. "Many of our alumni return as industry sponsors with new projects for our students, who provide them with value and receive real-world experience in return."

UDME PhD Student Receives Allan P. Colburn Prize

The 2017 Allan P. Colburn Prize in mathematical sciences and engineering was awarded to SUBRAMANI SOCKALINGAM in mechanical engineering, whose dissertation–"Transverse Impact of Ballistic Fibers and Yarns"–was co-chaired by JOHN GILLESPIE and MICHAEL KEEFE. Sockalingam digs into the tiniest details of protective fabrics — such as Kevlar — to show how they respond under ballistic pressure. Using models, simulation and unique experimental approaches, he predicts the progression of fabric failure with nanometer precision.

"The depth and breadth of his research work surpasses the levels in all but a few of the dissertations I have seen in my 30-plus years teaching at the University," Michael Santare, professor of mechanical engineering, wrote in his letter of nomination. "... It is rare to find a researcher with Dr. Sockalingam's combination of intellect, creativity and hard work."

His work has prompted researchers at the U.S. Army Research Laboratory, Southwest Research Institute, Sandia National Laboratory and Purdue University to study these mechanisms at micron and microsecond scales for the first time, said Gillespie, director of the Center for Composite Materials.

"His research is having national and international impact," Gillespie said.

His research was supported by the Army Research Laboratory as part of a nationwide university consortium led by the University of Delaware, Johns Hopkins University, CalTech and Rutgers University.

DRIVING HIGH-SPEED INNOVATION

Blue Hen Racing team heads to DC festival with UD-built Formula car

As a little kid, Sean Nelan carried a socket wrench wherever he went. Cars were his thing.

So when he was a high school student touring the University of Delaware campus and saw the Formula Society of Automotive Engineers shop in Spencer Laboratory, he had the feeling UD was the place for him. Now a senior and president of UD's FSAE student chapter, Nelan has helped to steer the Blue Hens back into international competition with a UD-designed, built and tested Formula-style car.

As they did last year, Nelan and other members of the Blue Hen Racing team plan to travel to Lincoln, Nebraska, in June to compete against student teams from around the world.

But first, they hauled their 2017 race car to Washington D.C., for display at the U.S. Science & Engineering Festival, held April 7-8, 2018 at the Walter E. Washington Convention Center.

Powered by a Kawasaki Ninja ZX636R engine, the car goes from 0 to 60 mph in 4.4 seconds, with a top speed of about 130.

The team didn't flex that muscle in Washington. There, they talked engines, parts, design details and test results with anyone who stopped by. That's the fuel behind the team - learning about cars and engines, what makes them run, what makes them fast and how to design and build better, faster, more efficient ones.

In constructing their car, UD students on the Blue Hen Racing team partnered with the College of Engineering's Center for Composite Materials in using its carbon fiber material in the car's body work. The composite helps with the car's handling in corners.

Designing the car allows students to apply what they have learned in their engineering studies.
It takes lots of time, patience and resourcefulness. The team doesn't have the multimillion-dollar budget of professional Formula 1 teams. But it does have plenty of engineering power as part of the Department of Mechanical Engineering's Senior Design capstone course. Steve Timmins is the faculty instructor of that class and the advisor for the FSAE team.

Timmins said the course had 15 students working in five groups - aerodynamics, chassis, suspension, ergonomics and drivetrain.

"By the end of one semester, the car - completely built from scratch - was about 80 percent complete," Timmins said.

Ordinarily, Nelan said, they would cannibalize a previous model - using its parts in a new design.

But this year's car is a "ground-up design," Nelan said - completely re-configured with all new parts.

"This year, Spencer [Lab] got a new CNC [computer numerical controlled] mill that allowed us to make parts a lot faster," he said. "We redesigned all the old parts. Some weren't designed correctly."

This year's team is made up of undergraduate students, but the rules say graduate students can participate, so Nelan - who plans to begin work on a doctoral degree at UD next fall - could be part of future projects. He's not sure he will because of the demands a doctoral program makes, but he could if he wanted to.
Many team members are engineering students, of course - and many incorporate work on this car into their senior design project. But some students are from seemingly unrelated majors, including finance and hotel management.

"You don't have to have any background or prior knowledge in cars," Nelan said. "In fact, a lot of our best people have no background in cars. If you show up, you're excited to work and have a good attitude, you're universally accepted on the team."

The UD program started about 20 years ago when the FSAE was quite young, Nelan said.

Nelan said the competitive element of the club had lapsed for a few years and when he joined the team in his freshman year, there was no car to race. So in his sophomore year, he and some other team members went to Lincoln to see what the competition was like. They returned eager to be part of it.

Last year, 17 students put UD back in the action and the Blue Hens finished 43rd of 100-plus teams. With a new design and new parts, Nelan said he thinks the 2018 car could finish in the top 20.

In recent years, 3-D printing has been an increasingly significant part of the manufacturing process.

"It has really enabled us to take parts you would not otherwise be able to make on a standard milling machine," Nelan said. "Our dashboard, battery box and hubcap dust shields are all 3-D printed.

At Lincoln, the car will be tested in five events - acceleration, braking, skidpad (a tight figure-8), autocross (one run down a track) and endurance (a two-driver, 30-lap event).

Many team members go on to work in the automotive industry, he said. He plans to work for the Department of Defense, doing research on radar and guided missile destroyers.

But first, there's some racing to do.

"A lot of our best people have no background in cars. If you show up, you're excited to work and have a good attitude, you're universally accepted on the team."

READY FOR TAKEOFF

UD engineering students build, fly a radio-controlled aircraft

KYLE PANARIELLO, a senior mechanical engineering student, was in the middle of a final exam in December when he saw a sign pressed against the door that read: WE'RE FLYING.

The message came from one of his teammates in Senior Design, a one-semester capstone engineering design program. Over the course of the fall semester, Panariello and seven other engineering students had built a gas-fired, wooden remote control plane. Now, it was time for the first test flight.

The radio-controlled plane is sent aloft by UD engineering students, who designed and built the aircraft for their Senior Design project.

Panariello, who is in the process of becoming a certified private pilot, got butterflies in his stomach. He hastened his pace so that he could finish the test in time to join his teammates at a field at Lums Pond State Park in Bear, Delaware.

There were some last-minute tweaks to the blue and yellow plane. Right before takeoff, the throttle closed and the tail popped—some epoxy had to be applied on site. But then the team sent the plane speeding ahead for about seven seconds, and it was time to go airborne.

"Once the plane was started, I carried it over the runway, and I couldn't have been any more excited," Panariello said. "When the plane took off I was overcome with a surreal feeling and I couldn't have been any happier."

The team watched in awe as the blue and yellow plane soared above 300 feet in the air and landed safely on its landing gear on a rough terrain about eight minutes later.

"I'm not going to lie—when the plane took off, a lot of us almost got teary-eyed," said Parth Modi, a member of the design team and former SpaceX intern.

GROUNDWORK PRECEDES FLYING

This project came together after Christos Sarmousakis, a senior mechanical engineering student with a concentration in aerospace engineering, learned about the SAE Aero Design East competition, which challenges teams of college students to design functional aircraft. This contest is held by SAE International, an association of engineers and related technical experts in the aerospace, automotive, and commercial vehicle industries.

Sarmousakis petitioned to have an SAE Aero Design project added to the offerings in UD's Senior Design program. His team members, all seniors in mechanical engineering, joined enthusiastically.

In just one semester, the eight-member team went through the four phases of the capstone design course from problem definition and conceptual design to prototype building and testing; they used raw materials and software like SolidWorks, a computer-aided engineering modeling program, to design and build a functional, light, and strong plane.

"To start with wood, SolidWorks, and the teammates on my right and left and end up with this plane—it's incredible rewarding," said Anthony Balestra, a member of the design team.

The whole process was a test of each team member's ability to solve problems and learn on the...well, yes, the fly. The team reached out to numerous outside sources to connect the dots in order to complete this newly launched UD project. The team did not compete in Florida at the SAE Aero Design East competition after all—only a limited number of teams could enter—but they earned a victory of their own.

"The project makes for a true project-driven active learning experience, and the students' usual coursework finds a wonderful real-world connection," said professor Lian-Ping Wang.

He said the lessons learned from this project will last a lifetime. "For me as the faculty adviser, seeing students applying knowledge in basic fluid mechanics, solids mechanics, and material science to build a functional plane is a very rewarding experience," said Wang. "I see how good motivation goes a long way to provide an integrated system-level learning experience. The format of the mechanical engineering Senior Design course allows students to really work as a team to develop optimal solutions in an iterative manner. The students are on their way to becoming innovative engineers!"

STUDENT INVENTION A SUCCESS ON KICKSTARTER

UD engineers design, crowdfund a levitating top

ONLY 36 PERCENT OF KICKSTARTER PROJECTS ARE SUCCESSFUL.

ADAM STAGER passed his funding goal of $5,000 in just 48 hours during a Kickstarter campaign in January 2018.

Stager, a doctoral student in mechanical engineering, is co-founder of Infinity Top. Described as the "perfect desktop companion," this top spins above its base.

The spinning tops come in three materials: aluminum, stainless steel, and brass. Each floats at different heights due to their differences in mass. The lightest, aluminum, spins more than a half-inch above the base. The heaviest, brass, floats lower, at a quarter-inch above its base. Each material has its own unique spin feel and characteristic, said Stager.

This levitation is no magic trick—it's a magnet trick. The top contains a magnet, and its base that contains electromagnets and a ring magnet.

"The top sits on a pillow of magnetic field," said Stager. Because gravity is defied and friction is minimized, this top can spin longer than a conventional one. Advanced users can easily keep the top spinning for 30 to 45 minutes, according to Stager.

This isn't the first levitating spinning top on the market, but it is an improvement over previous designs. The electromagnet makes the Infinity Top easy to set up and also keeps it spinning longer than other iterations.

"Uniquely, the Infinity Levitating Top will continuously levitate, is much easier to set up and has recorded spin times over one hour," said Stager.

What's more, the design of the Infinity Levitating top makes it not only a fun experiment, but also a beautiful display piece, he said.

THE INVENTION PROCESS

Flyte, a levitating light bulb that hit Kickstarter in 2015, inspired Stager. He wanted to design a top that would float and spin at the same time, a fun twist on a nostalgic toy. He tabled the thought for about a year, until he met Caili Li, who was then a UD student earning a master's degree in mechanical engineering. The two met in the lab of Herbert Tanner, an associate professor of mechanical engineering at UD.

"The two of them make a marvelous duet," said Tanner. For one, Adam is way more than just a great Ph.D. student. He is an amazing engineer, a team leader, and a serial entrepreneur. Caili, on the other hand, is one of the most well rounded, theoretically and experimentally capable masters students I have ever had. "

Li had experience with levitating objects and an interest in crowdfunding. He is the member of a family-owned manufacturing facility that has previously produced levitating objects. Li and Stager discussed their ideas and met at Stager's house that very same night to brainstorm. They used clay, a 3-D printer, and a variety of materials to put together models and drawings. Then Li secured prototypes.

As the team developed and marketed their product, Stager utilized skills he learned last summer in UD's Horn Entrepreneurship Summer Founders program—like the importance of seeking customer feedback. In Summer Founders, Stager developed another startup company, TRIC Robotics, which develops modular robots to provide real-time information to first responders in emergency situations.

"As a mechanical engineer, you often work behind the scenes," said Stager. "This is a great opportunity to interact with customers and really see the impact of a product on their lives."

Stager received a bachelor's degree in mechanical engineering from UD in 2011. After two years as a process engineer at L'Oreal, he returned to UD to seek a doctorate. He worked with Andreas Malikopoulos, associate professor in mechanical engineering, on UD's Scaled Smart City, and he works with Tanner, his advisor, on mobile ground robots.

UD STUDENT NAMED 2018 CROSS SCHOLAR

The award recognizes future leaders of higher education

ANAHID EBRAHIMI, who earned her doctoral degree in mechanical engineering at UD in 2018, is a recipient of this year's K. Patricia Cross Future Leaders Award from the Association of American Colleges & Universities. She is one of seven graduate students nationwide, and the only engineering student, to be named a Cross Scholar in 2018.

"The K. Patricia Cross Future Leaders Award recognizes graduate students who show exemplary promise as future leaders of higher education; who demonstrate a commitment to developing academic and civic responsibility in themselves and others; and whose work reflects a strong emphasis on teaching and learning," the Association of American Colleges & Universities said in a statement announcing the awards. "The awards honor the work of K. Patricia Cross, Professor Emerita of Higher Education at the University of California-Berkeley."

Ebrahimi joined UD after earning a bachelor's degree in biomedical engineering at the University of California-Davis. At UD, Ebrahimi worked with professor Steven Stanhope on body weight supported treadmill training, particularly to improve mobility in people who have had a leg amputation, and she worked with professor Jill Higginson on musculoskeletal modeling techniques.

She is now a post-doctoral associate at the University of Wisconsin-Madison.

Through her research activities, Ebrahimi aims to understand compensatory mechanisms in individuals with gait impairment with particular emphasis on implications for prosthetics and orthotics. She developed a novel Constituent Lower Extremity Work (CLEW) methodology to study lower extremity joint contributions to whole body energetics, and she is using this technique to study the energetics of normal gait, with the ultimate goal of improving the design of lower extremity prosthetic devices.

She is also passionate about education. At UD, she combined research and teaching in a project to assess students' perception of learning in the mechanical engineering curriculum. She also mentored eight undergraduate students in their research projects and lectured in nearly 20 classes and seminars of various disciplines, including engineering, physical therapy, and biomechanics and movement science. In fall 2016, she helped Higginson develop a new course, Biomechanics of Superheroes, which explores human performance in the context of mechanical concepts such as strength, size and control.

Ebrahimi is also dedicated to outreach and service activities to educate others about biomechanics and encourage young women to pursue science, technology and mathematics careers.

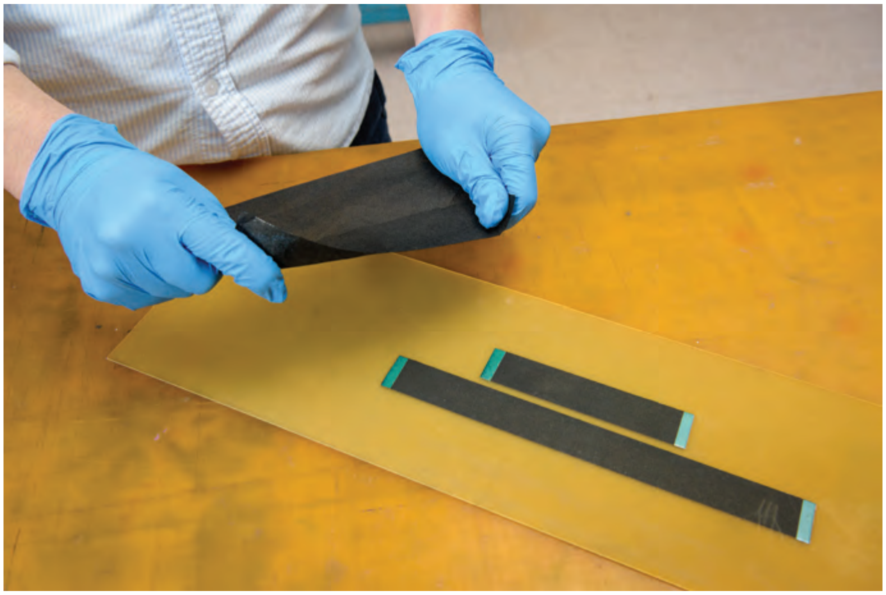
"Ana honestly amazes me with her boundless enthusiasm for biomechanics, which she so eagerly shares with all audiences," said Higginson.

Ajay Prasad, the chair of UD's mechanical engineering department, said: "This is a very prestigious national award and could not have happened to a better person. Ana has been an exemplary graduate student in our department, excelling not only in her doctoral research, but also in outreach activities to promote STEM and serving on several important committees. She is passionate and generous with her time to others. We wish her the best as she completes her Ph.D. and moves on to the next challenge!"

Ebrahimi plans to become an academic professor.

Using sensors to spot infrastructure damage

UD team commercializes structural health monitoring systems



An entrepreneurial team, Smartenius, consisting of HAO LIU (Entrepreneurial Lead), HONGBO DAI (Team Member), ERIK THOSTENSON (Faculty Advisor) and WILLIAM JOHNSON (Business Mentor) based at the University of Delaware has worked on the commercialization of a system that could make infrastructure such as bridges and pipelines safer. The team stood out in a field of more than 700 startup companies/teams and earned a coveted spot as one of the 42 final teams in the Rice Business Plan Competition at Rice University from April 5 to 7. Billed by Rice as "the world's richest, largest student startup competition", this event pits student startups from around the world against each other as they compete for $1.7 million in cash and prizes..

Almost 40 percent of America's bridges are 50 years or older, and 188 million daily trips happen on structurally deficient bridges, according to the American Society of Civil Engineers. Sometimes emergency bridge repairs can avert a crisis in the nick of time, such as the fixes to Delaware's I-495 bridge in 2014 after engineers found cracks in its concrete and deformations in its steel piles. However, those fast repairs can be costly—in this case, $45 million for three months. When bridges fail, the results can be tragic. On March 15, six people died when a pedestrian bridge collapsed in Miami, Florida.

The Smartenius team has developed a system to monitor the structural health of bridges using three major components: sensors that can be placed in or on bridges, data acquisition hardware and data analysis software. "We can attach or embed these low-cost and high-accuracy sensors to structures to detect the damage or deformation of the structures," said Hao Liu, entrepreneurial lead of Smartenius. He is a doctoral student in mechanical engineering with a focus on composites and advanced materials at UD. "If any damage is occurring, the data acquisition system will transmit the change detected by sensors and the analysis software will quantify it," said Hongbo Dai, who is Liu's teammate and a postdoctoral researcher working on multifunctional composites. He is a recent UD graduate with a Ph.D. in civil engineering with a concentration in structural engineering.

So far, the technology has been tested in labs, but the team is undergoing negotiations to test it in the field later this year.

Liu came to Delaware in 2012 to study mechanical engineering and focus research on composite materials at UD's internationally recognized Center for Composite Materials (CCM). Under the mentorship of his advisor Erik Thostenson, an associate professor of mechanical engineering and affiliated faculty of materials science and engineering, Liu began studying advanced composite materials.

"When I came here, I didn't have any ideas regarding startups," Liu said. "I just wanted to finish my Ph.D. and go get a job as an engineer or research scientist."

That all changed when Liu attended a series of Startup 101 seminars

continued on next page

organized by Yushan Yan, the College of Engineering's associate dean for research and entrepreneurship. Liu had a hunch that the technology he was working on might be marketable to companies or government agencies that build and maintain infrastructure.

"This team is going places," said Yan. "They are quickly gaining attention on the national stage because their invention has great potential to make road travel safer."

Thostenson, the faculty advisor for the team, has supported Liu and Dai in their entrepreneurial efforts as they pursued their doctorates under his advisement.

"The interdisciplinary environment of CCM has greatly facilitated their growth as researchers and entrepreneurs. CCM is a unique environment in terms of both facilities and personnel," said Thostenson. "A number of my students have been involved with Horn Entrepreneurship and the NSF I-Corps programs and that has provided additional mentorship in entrepreneurship and commercialization of research. As an engineer, I am excited to see innovations from our labs transformed to future applications."

Jack Gillespie, the director of CCM, said: "For 40 years, CCM has fostered entrepreneurship and innovation with our alumni, small businesses, new startups and through our industrial consortium by helping engineers and scientists turn their discoveries into reality. Over that time, composite materials have changed the game in many industries, and their use in structural health monitoring holds a lot of promise."

Through Horn Entrepreneurship, UD's creative engine for entrepreneurship education and advancement, Liu participated in the National Science Foundation (NSF) I-Corps Sites Program, a program that nurtures burgeoning startups. Then, at the encouragement of Dan Freeman, the director of Horn Entrepreneurship, and Vince DiFelice, manager of venture support, Liu applied for the national version of the program and was selected as a national I-Corps team lead, which gave him the opportunity to participate in a 7-week entrepreneurial boot camp in the Los Angeles cohort in the fall of 2016.

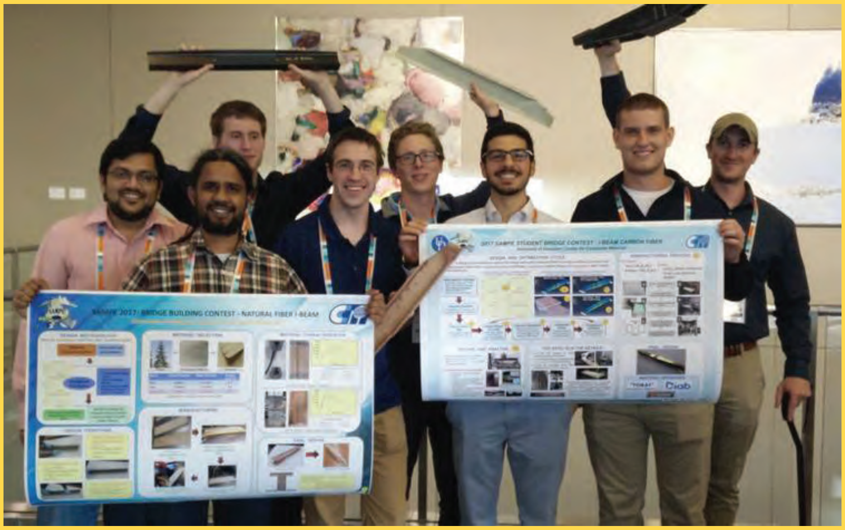
"We had to finish more than 100 interviews within seven weeks during the national I-Corps team program. It was really tough, especially at the beginning," Liu said.

In 2016, Liu won first prize in the 11th Chunhui Cup National Innovation and Entrepreneurship Competition for Chinese students studying overseas. Late last year, the team received a grant from VentureWell's E-Team program. Earlier in March, with the help and encouragement of Christina Pellicane, director of commercialization programs at Horn Entrepreneurship, Liu was selected for the Post-Doctoral Innovation Fellowship with the UD's Blue Hen Proof of Concept Program. This offers him a full-time position to stay and continue working on entrepreneurship after his Ph.D. graduation this summer. Through these supports, Liu has interviewed more than 450 prospective customers from all over the world to gain insight on their needs, and opportunities keep coming.

Will Johnson, the business mentor for Smartenius and business development specialist in UD's Office of Economic Innovation and Partnerships, has helped the team with technology transfer, patent applications, and negotiations with investors. He has more than 30 years of experience in private industry and regularly interacts with innovators. He sees something special in Liu and Dai.

"What makes them different is their desire, their drive to commercialize," said Johnson. "Lots of people have ideas, but not everyone takes the steps to make them happen. Not everyone has the fortitude to keep pushing forward."

Liu's advice for anyone with a new business idea? "Just try it," he said.



ME Students Win at SAMPE

Congratulations to the ME students who participated in the Society for the Advancement of Material and Process Engineering (SAMPE) Bridge Contest at the international technical conference in Seattle. They competed with universities from around the globe and received five awards, placing second overall.

THESES AND DISSERTATIONS

ANDREW BAKER
DISSERTATION: "Enhancing the chemical and mechanical durability of polymer electrolyte membranes for fuel cell applications"
ADVISOR: Suresh Advani and Ajay Prasad

OZAN EROL
DISSERTATION: "Multi-length scale finite element design framework for advanced woven fabrics"
ADVISOR: Michael Keefe

DIANA HAIDAR
DISSERTATION: "A new solution to an old problem: designing an ultralow wear polymeric solid lubricant for bearing applications in challenging environments"
ADVISOR: David Burris

JIAYIN WANG
DISSERTATION: "Integration of composite part design and processing simulation in liquid composite molding"
ADVISOR: Suresh Advani

VENKATESWARAN SANTHANAM
THESIS: "Anisotropic fracture toughness in graphene"
ADVISOR: M. Zubaer Hossain

VICTOR GAO
THESIS: "The microstructure of osteocytic lacunar-canilicular system varies with age and bone mineral density in osteoporotic and osteoarthritic patients"
ADVISOR: Liyun Wang

CAILI LI
THESIS: "Star-world navigation functions for convergence to a time-varying destination manifold"
ADVISOR: Herbert Tanner

DIAN JIAO
THESIS: "Horizontal motion planning for multi-legged robots"
ADVISOR: Herbert Tanner

NING YE
DISSERTATION: "The interfacial thermal conductance of epitaxial metal-semiconductor interfaces"
ADVISOR: Joseph Feser

TENGYUAN HAO
THESIS: "Effective mechanical properties in carbon nanotube-silica nanocomposite"
ADVISOR: M. Zubaer Hossain

BENJAMIN MCNEALY
DISSERTATION: "Interpreting impedance spectra of thin-film electrochemical cells: a two-dimensional numerical modeling study"
ADVISOR: Joseph Feser

DAN BUESKING
THESIS: "Multiscale modeling of composite materials: effect of textured fibers on interfacial properties"
ADVISOR: Michael Santare

SEYED MOHAMAD SHAFIEE MOTAHAR
DISSERTATION: "Control and motion planning of dynamically walking bipeds for cooperative transportation"
ADVISOR: Ioannis Poulakakis

HONG YU
DISSERTATION: "Modeling and characterization of electrical resistivity of carbon composite laminates"
ADVISOR: Suresh Advani

ANAHID EBRAHIMI
DISSERTATION: "The development and application of a framework for exploring the energetics of gait strategy adaptations"
ADVISORS: Jill Higginson and Steven Stanhope

ROSA KOLBEINSDOTTIR
THESIS: "Shank kinematics and kinetics in prosthetic gait: Implications for improved design of prosthetic systems"
ADVISOR: Jill Higginson

DONGMIN SHIN
THESIS: "Optimization of an on-board fuel cell system for submarine operation"
ADVISOR: Ajay Prasad

Student Honors

Congratulations to the following ME students recognized for outstanding achievements in academics and research!

UNDERGRADUATE AWARDS

W.Francis Lindell Mechanical Engineering Award to the Distinguished Senior
Presented to Elizabeth Racca, Thomas Celenza

Mary and George Nowinski Award for Excellence in Undergraduate Research
Presented to Francis Klincewicz

ASME - Delaware Section Outstanding Senior Design Final Presentation Award
Presented to Team Norwalt: Matthew Blasi, Thomas Celenza, Christopher Kitson, Alex Nugent, Andrew O'Hern, Matthew Seitel, Joseph Simon, Ke (Chester) Xi

W. Francis Lindell Mechanical Engineering Award to the Distinguished Junior
Presented to Christopher Blackwell, Ben Silverman

W.Francis Lindell Mechanical Engineering Achievement Award
Presented to Rebecca Williams, Haley Lloyd

Delaware Section of The American Society of Mechanical Engineers Outstanding Student
Presented to Marissa Bisram

American Society of Mechanical Engineers Student Section
Presented to Christopher Kitson

ME Alumni Award - Outstanding Senior
Presented to Keirstin Hughes, Joshua Graessle

ME Alumni Award - Outstanding Junior
Presented to Taylor Coleman, Michael Palmer, Tiange Zhang

ME Alumni Award - Outstanding Sophomore
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GRADUATE AWARDS

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Graduate Achievement Award
Presented to Sagar Doshi, Nicole Ray

1st place in SAMPE Baltimore-Washington Student Symposium
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Distinguished Student Award from Los Alamos National Lab
Presented to Andrew Baker

2018 Elisa Conover Fellowship for Fluid Dynamics Research
Presented to Arham Amin Khan

Best Poster in 2018 CANR Research Symposium
Presented to Adam Stager

Doctoral Fellowship Awards
Presented to Rohit Kakodkar
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Dissertation Fellowship Awards
Presented to Sagar Doshi

CCM AWARDS GIVEN TO ME STUDENTS

R. L. McCullough Scholars Award
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Progress Award
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ENGINEERING CHANGE ABROAD

Engineers Without Borders helps UD alumni launch careers in international development

For SARAH HARTMAN and MELISSA LANDMAN, one small decision to join the University of Delaware's chapter of Engineers Without Borders set them on a greater path toward a profession in international development, a journey which has landed them, most recently, in Mexico.

Both 2017 graduates, Hartman got her degree in environmental engineering and Landman got hers in mechanical engineering. Both were managers on a EWB-UD project in the Philippines.

They left in October 2017 for San Miguel de Allende, Mexico, where they began work with the local non-profit Caminos de Agua. Founded in 2012, Caminos de Agua researches, develops and implements sustainable solutions to bring potable water to residents in the state of Guanajuato. This is no small feat.

"The state is located high in the mountains and in an arid environment, and to begin with has water quantity challenges," Hartman said. She added, "the bedrock in the state also has naturally-occurring arsenic and fluoride, creating additional water quality issues."

The majority of water used for agriculture and drinking in Guanajuato makes its way up from the deepest levels of the Independence Aquifer with higher-than-recommended levels of arsenic and fluoride. Sustained exposure to these chemicals can cause severe medical issues in children and adults.

"To address these concerns, the non-profit has the primary goal of helping communities collect rainwater from the roofs of schools and houses," Hartman said. "This water is redirected into cisterns for use. Caminos de Agua has also developed a ceramic filter to help remove bacteria and particulates from rainwater."

The ceramic filters are the target of Landman's work.

"Right now, I am focusing on improving the manufacturing process of the filters and creating an adaptor which will allow for more flexible use," Landman said. Her work involves visiting the sites where the filters are made and used, talking to experts who work with ceramics, and going back to the lab to test various changes in the product.

Hartman, too, is focused on water filtration technologies, "developing a filter for arsenic and fluoride so that if residents needed to drink the groundwater, they could."

Clean groundwater is especially important, she said, because "at this point, we don't have an alternative to rainwater that we can provide."

According to Hartman, both are also absorbing valuable lessons from their colleagues at Caminos de Agua and members of the greater community.

"No matter where we are or what we are doing, we are always learning something," she said. "Whether it be professional, social or maybe even a few words of Spanish. We've met a lot of amazing people here from completely different walks of life."

The team will work with Caminos de Agua through July 2018, when they will return to the United States and seek the next step in their international development careers. As they look forward, Hartman and Landman reflect on the value of their undergraduate experiences at UD.

"Joining EWB was probably the best decision of my life," Landman said. "I learned so much from being a part of the organization for four years and from my experience in the Philippines. I came away with not only technical knowledge, but having networked and met with new people from many backgrounds. It really opened my eyes to international development and how you can use technology to help people."

Thank you to our donors!

We wish to thank the many ME friends and alumni who have made generous contributions between July 1, 2016 and June 30, 2017. Your gifts are used for many worthwhile purposes, including support of our fundamental interdisciplinary research and educational programs.

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ANDREAS MALIKOPOULOS is researching ways to maximize fuel efficiency in a connected and automated vehicle (CAV). These vehicles use sensors, cameras and advanced control algorithms to adjust their operation to changing conditions with minimal or no driver input. He develops and implements control technologies to allow vehicles to bypass roadblocks, change speed based on traffic conditions, and adjust their powertrains to optimize efficiency.

Malikopoulos has been appointed the inaugural Terri Connor Kelly and John Kelly Career Development Professor of Mechanical Engineering effective September 1, 2018 for a five-year term. He is a fellow of the American Society of Mechanical Engineers and a senior member of IEEE. He is also a member of UD's Center for Fuel Cells and Batteries, where researchers from across the College of Engineering collaborate to develop eco-friendly fuel technologies.

Before joining UD in 2017, Malikopoulos was the deputy director and the lead of the Sustainable Mobility Theme of the Urban Dynamics Institute at Oak Ridge National Laboratory, and a senior researcher at General Motors Research & Development. Malikopoulos earned his doctoral degree in mechanical engineering from the University of Michigan, Ann Arbor.

TERRI CONNOR KELLY AND JOHN KELLY CAREER DEVELOPMENT PROFESSORSHIP IN MECHANICAL ENGINEERING

UD Mechanical Engineering alumna TERRI CONNOR KELLY '83 and JOHN KELLY '83 established the Terri Connor Kelly and John Kelly Career Development Professorship in Mechanical Engineering to aid in growing the ranks of talented young engineering faculty at the University of Delaware. Career Development Professorships are a critical tool in recruiting the most promising young faculty and jumpstarting their professional achievements. For information on establishing or contributing to our endowed professorship funds, please contact Dan Rogalski at rogalski@udel.edu.

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