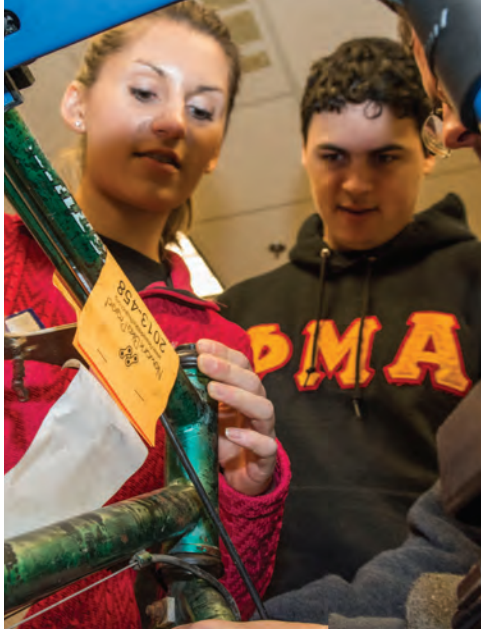
University of Delaware | College of Engineering

Department of

Mechanical Engineering



2015 News

AND ANNUAL REPORT

INSIDE

Spotlights on our High-Impact, Multidisciplinary Research:

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

University of Delaware | Department of Mechanical Engineering

Message from the Chair

It's been another productive and successful year for the Department of Mechanical Engineering (ME). On the following pages, you'll read about cutting-edge research by our renowned faculty and graduate students, senior design innovations by our mechanical and biomedical undergraduate engineering students, and impressive accomplishments of our alumni.

Our faculty continue to achieve national recognition in their areas of focus. Among the many honors to our department this year for interdisciplinary collaboration leading to the fundamental discovery that drives innovation and future application were a number of research grants from the National Science Foundation and awards from the American Society of Composites and the Society of Plastics Engineers.

Throughout this magazine, you'll get a glimpse of the breadth and depth of research being advanced by our internationally acclaimed faculty in five core areas—biomedical engineering, clean energy and environment, composites and advanced materials, nanotechnology, and robotics and control. We'll also highlight the work of several of our faculty whose research and leadership epitomize the caliber of academic advancement stemming from our department.

We've been honored to welcome U.S. Senator Chris Coons several times to campus this year, including offering him a driver's seat look at the Blue Hen Racing Car #42 designed and built by UD's Formula Society of Automotive Engineers Club as part of the collegiate design competition. Sen. Coons' visit to UD's Science, Technology and Advanced Research (STAR) campus tied in with legislation to promote education and skills-training reforms. He also visited our new Interdisciplinary Science and Engineering Laboratory (ISE Lab) last fall to receive the Science Coalition's Champion of Science Award in recognition of his strong commitment to funding the basic research that keeps our state and nation at the forefront of scientific and medical discovery and technological innovation. And this spring, he met with faculty and students at UD's Center for Composite Materials to get a closer look at the fundamental research being advanced by our department.

Another honored guest to campus—this one of the four-wheeled variety—was Toyota's new fuel cell vehicle, the Mirai. Faculty and students from ME's Center for Fuel Cell Research helped Toyota showcase the Mirai on a recent cross-country tour.

The department's Career Celebration and Senior Appreciation day is always a highlight of our year. In this section, you'll meet this year's four alumni honorees, whose impressive careers epitomize what is possible with a UD ME education. Honoree **PAUL COSTELLO, BME '66,** chairs our department's advisory council and **VANCE KERSHNER, BME '79,** leads the advisory council for the College of Engineering. We thank both of them for their outstanding leadership and applaud all four recipients. You'll also enjoy a glimpse of the outstanding work created and crafted by our senior design teams. Suffice it to say that impressive talent is entering the workforce from our department!

ME faculty and students are collaborating on exciting ventures with colleagues from other engineering disciplines, and with departments throughout the University that might surprise you—nursing, physical therapy and the arts to name a few—to solve mysteries, tackle problems and invent new technologies all aimed at enhancing quality of life. This enthusiasm for interdisciplinary research sets the stage for our 125th anniversary commemoration in 2016. Be sure to visit **www.me.udel.edu/125** to share your ideas on how to celebrate this quasquicentennial milestone.

Our first 125 years—and indeed the future success of our department—would not be possible without the generous contributions of many alumni, friends, faculty and staff who continue to help us prepare the next generation of mechanical engineers. To all, I extend a sincere thank you for your ongoing encouragement and generosity.

Best regards,

Suresh Advani
George W. Laird Professor and Chair

Content Direction: Department of Mechanical Engineering
Writing & Design: College of Engineering Communications Team
Photography: Communications & Public Affairs

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 regarded 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 Cell Research (CFCR). Other affiliated research centers and institutes include the Center for Composite Materials (CCM), the Delaware Rehabilitation Institute (DRI) and the University of Delaware Energy Institute (UDEI). 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 $9 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

Department at a glance

Faculty

5 Named/Chaired Professorships
5 Full Professors
6 Associate Professors
9 Assistant Professors

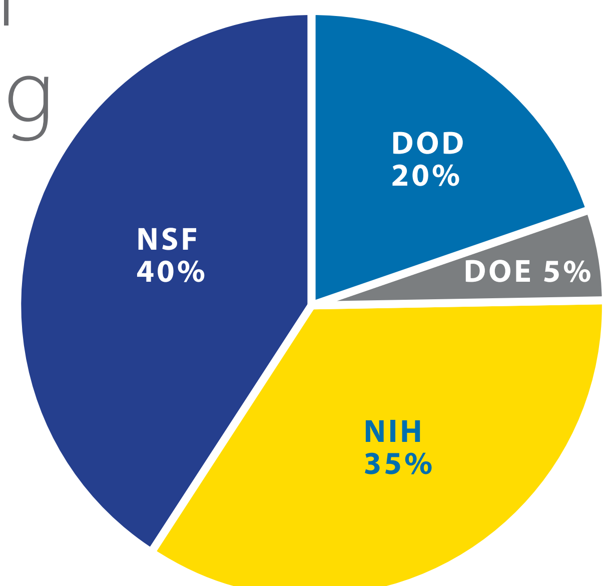
Degrees Awarded

105 Bachelor's
18 Master's
10 Ph.D.
133 Total

Enrollment

450 ME Undergraduate
85 ME Graduate
535 ME Total

Federal Funding

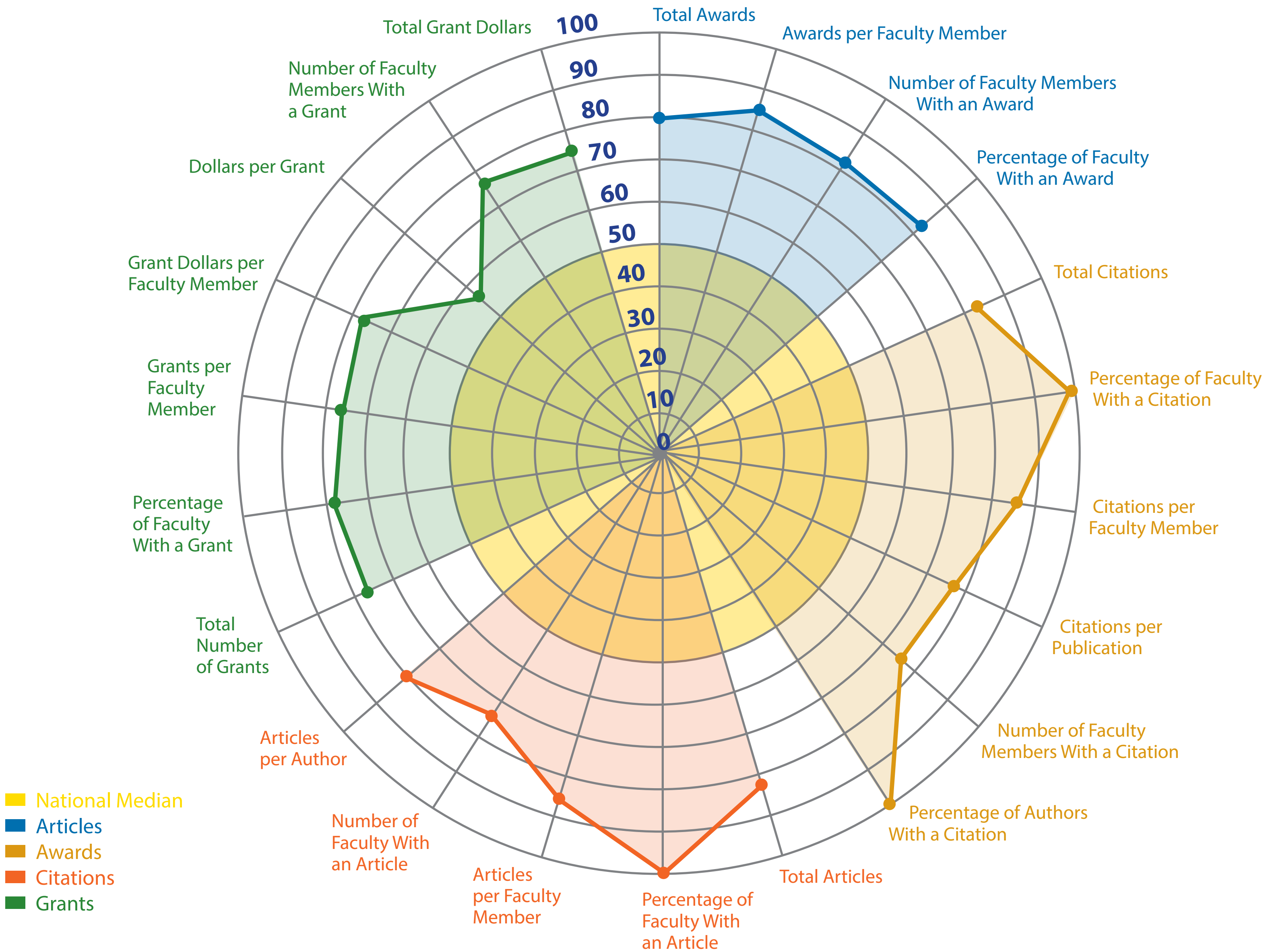


Faculty Publications

99 Journal Articles
212 Conference Publications/ Presentations
5 Journal Editors

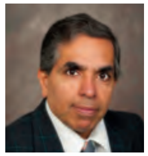
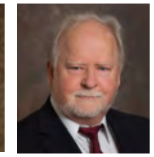
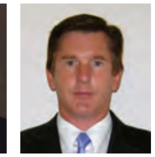
Department Analytics

Percentile rank compared to ME programs nationwide

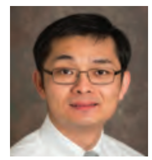
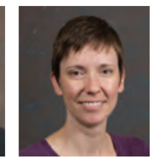
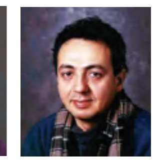


Fundamental data provided by Academic Analytics AAD 2013 on May 1, 2015.

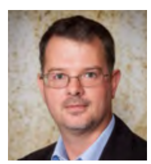
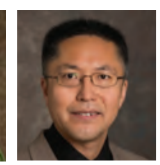
Mechanical Engineering Faculty Research

	Suresh Advani	Thomas Buchanan	Jenni Buckley	David Burris	Tsu-Wei Chou	Heather Doty	Joseph Fesser	Jack Gillespie	James Glancey
Biomedical Engineering		■	■	■				■	
Clean Energy and Environment	■			■			■	■	
Composites and Advanced Materials	■			■	■	■	■	■	■
Nanotechnology				■	■	■	■	■	
Robotics and Controls									

	Jill Higginson	Guoquan Huang	Michael Keefe	X. Lucas Lu	Kurt Manal	Ioannis Poulakakis	Ajay Prasad	Dustyn Roberts	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			■				

Biomedical Engineering

Tribology team hopes understanding soft tissue tear/OA connection leads to better joint replacement materials

The cartilage in our joints is designed to last a good 80 years without injury.

But with injury, such as ligament and meniscus tears, comes the likely complication of post-traumatic osteoarthritis (PTOA).

"The prevailing hypothesis of why soft tissue tears lead to osteoarthritis has to do with the kinematics of the joint," explains tribology expert **DAVID BURRIS**, associate professor of mechanical engineering. "Injury to these joint support structures alters joint kinematics, which brings new areas of cartilage into contact. It is thought that these new areas are more likely to fail because they have not been conditioned to the new contact stresses."

Burris and doctoral student **AXEL MOORE** set out to detect evidence that cartilage conditioning varies from one location to another using new high resolution characterization methods they developed the year before.

In a recent study published in *Osteoarthritis and Cartilage*, the duo demonstrated that the materials and tribological properties of cartilage vary according to the nature of local contact conditions in the healthy joint.

"This is the first evidence of systematic tribological variability throughout a joint, which is the underlying premise of the altered loading hypothesis of PTOA initiation," they claim.

The study was conducted on a bovine model, but the team argues that the results are cautiously applicable to human PTOA because the observed variations are driven by fundamental biological processes.

The findings suggest that restoring normal kinematics may help combat PTOA. A specialty brace or exoskeleton may provide a more robust, tunable and less invasive means for controlling joint motion patterns than surgical repair.

PTOA eventually requires joint replacement; anyone who has gone through this knows a repeat surgery is likely in their future.

"Current cartilage replacement materials have nothing in common with native cartilage, so it's not surprising that replacement joints can't survive," said Burris. "Our ultimate aim is to apply our insights about cartilage function to the design of new cartilage replacement materials that better mimic native functions."

Osteoarthritis and Cartilage 23 (2015) 161e169.
http://dx.doi.org/10.1016/j.joca.2014.09.021
| *Funded by the National Institutes of Health.*

- Tibial cartilage exhibited significantly poorer material and tribological properties than femoral cartilage.
- Damage to the tibial plateau often precedes damage to the mating femoral condyle following joint injury in animal models.

Biomedical Engineering at a glance

Biomedical engineering integrates engineering design and problem-solving strategies with medicine and the biological sciences to help improve human health and quality of life. Research within the department applies engineering principles and techniques to the human body and medical field.

Areas of Expertise

- Cartilage biomechanics for osteoarthritis
- Cell mechanobiology for osteoporosis treatment and prevention
- Musculoskeletal modeling and simulation for healthy and impaired movement
- Neuromuscular control for stroke patients
- Sports medicine

Affiliated Research Centers

- Center for Biomechanical Engineering Research (CBER)
- Delaware Rehabilitation Institute (DRI)

Clean Energy and Environment

Clean Energy team optimizes PEM catalyst layer to advance fuel cells for automotive applications

Hydrogen-powered fuel cells are two to three times more efficient than internal combustion engines and boast water as their only emission. But while these Polymer Electrolyte Membrane (PEM) fuel cells are ideally suited for automotive applications, the high cost of the platinum catalyst used in their electrodes is a barrier to commercialization.

A clean energy research team from the Department of Mechanical Engineering's Center for Fuel Cell Research (CFCR) is employing modeling and simulations to improve the design of the PEM catalyst layer to reduce platinum loading without sacrificing performance.

AJAY PRASAD, Engineering Alumni Distinguished Professor of Mechanical Engineering and director of the CFCR, is studying PEM fuel cells, along with CFCR's graduate student researcher **FIRAT CETINBAS** and **SURESH ADVANI**, George W. Laird Professor of Mechanical Engineering and department chair. The team recently published their findings in the *Journal of Power Sources*, explaining how they employed the agglomerate model to optimize the spatial distributions of the multiple constituents that make up the PEM fuel cell catalyst layer (platinum, carbon and ionomer).

"It is well known that increasing the platinum loading improves electrode activity," said Prasad. "But the downside is reduced porosity. Similarly, increasing the ionomer loading improves protonic conductivity, but again, at the cost of reduced porosity.

"Our goal was to functionally grade the composition of the catalyst layer in both the in-plane and through-plane directions to maximize performance. We found that a higher catalyst and/or ionomer loading at the membrane/catalyst layer interface improves performance, especially in the ohmic loss regime. Similarly, improved performance is observed for higher catalyst and/or ionomer loadings under the channel in the mass transport loss regime."

The team also investigated bidirectionally graded catalyst layers for the first time, observing that higher performance can be obtained with bidirectionally graded catalyst layers in both ohmic and mass transport loss regimes. Although such spatially graded catalyst layers are difficult to manufacture with today's technology, future advances in manufacturing may be able to realize these optimized designs.

Journal of Power Sources 270 (2014) 594e602. http://dx.doi.org/10.1016/j.jpowsour.2014.07.148 | Funded by the Federal Transit Administration at the Center for Fuel Cell Research at the University of Delaware.

- Improved agglomerate model is used to study the PEM fuel cell catalyst layer.
- Catalyst and ionomer loadings varied in through-thickness and in-plane directions.
- Bidirectionally graded catalyst layers improve performance in both ohmic and mass transport loss regimes.

Clean Energy and Environment at a glance

One of the biggest challenges in today's world is sustainably generating, converting, transporting, storing and using energy. The department, with its traditional focus on thermodynamics, heat transfer and machine design, is well poised to respond to these concerns.

Areas of Expertise

- Wind energy
- Fuel cells, batteries, ultracapacitors, thermoelectrics and other energy-conversion devices
- Hybrid vehicle design and demonstration under intelligent control with real-time traffic feedback
- Computational fluid dynamics of warm rain, coal combustion and environmental-pollutant transport

Affiliated Research Centers

- Center for Fuel Cell Research (CFCR)
- Institute for Energy Conversion (IEC)
- University of Delaware Energy Institute (UDEI)

Composites and Advanced Materials

Integrating nanostructures to improve structural and functional performance of composite materials

The performance of composite materials depends strongly on the individual constituents—the fiber reinforcement and the polymer matrix—as well as the nature of the fiber/matrix interface. Using nanotechnology, it is possible to tailor composites for improved performance.

The research group of **ERIK THOSTENSON**, assistant professor of mechanical engineering, has pioneered the concept of hybridizing traditional microscale reinforcements, such as advanced carbon or glass fibers, with carbon nanotubes (CNTs).

"Because nanotubes are so small, they can penetrate the polymer-rich area between the fibers of individual yarn bundles, as well as the spaces between the plies of a fiber composite," said Thostenson, who is also an affiliated faculty member in UD's Center for Composite Materials (CCM).

"We have established a scalable and environmentally friendly approach for integrating carbon nanotubes in fibrous structures using electrophoresis," Thostenson explained. "The technique enables the nanotubes to fully penetrate fiber bundles and form chemical bonds with the fiber surface."

Key advantages of this hybridization approach—as opposed to energy-intensive techniques, such as chemical vapor deposition—are that it is carried out under ambient conditions, is industrially scalable and allows precise control over the interface chemistry.

The team published its work, "Polymer nanocomposite-fiber model interphases: Influence of processing and interface chemistry on mechanical performance," earlier this year in *Chemical Engineering Journal*.

They created model nanotube-fiber interfaces with the aim of accurately characterizing the chemical nature and understanding its role in mechanical performance. Through detailed analysis using high-resolution X-ray photoelectron spectroscopy (XPS) combined with mechanical testing, the team determined that when reinforcing fibers were modified with ozone-polyethyleneimine CNTs, the composite shear-strength increased significantly.

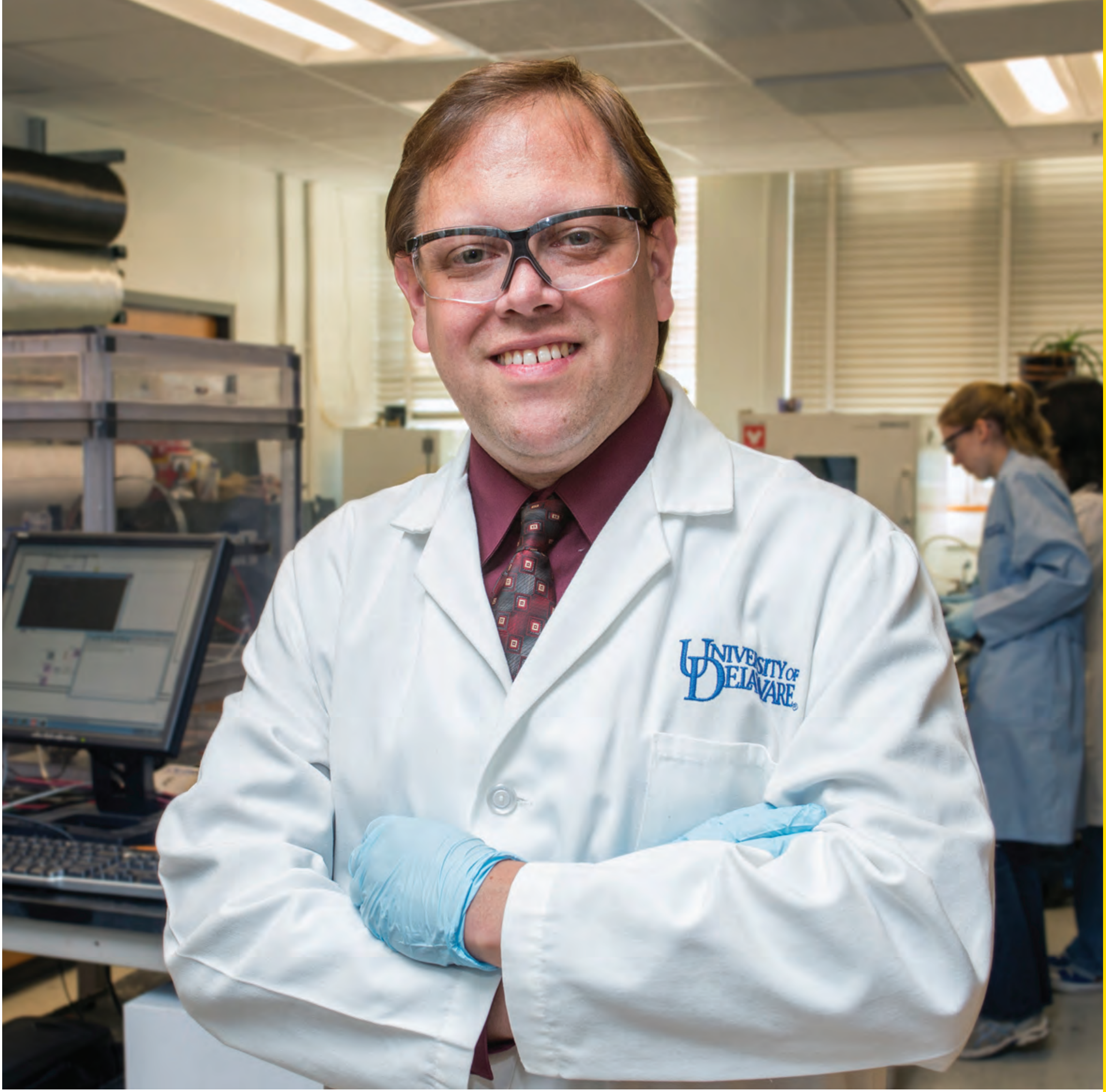
The nanotubes become completely integrated into advanced fiber composite systems, adding functionality without altering the microstructure of the composite.

"This is important for the future use of these hybrid materials, which offer remarkable improvements in shear strength, fracture toughness and electrical conductivity over traditional fiber-reinforced composites," Thostenson said. "Our work is paving the way for integrating adaptive, sensory and energy storage capabilities into structural composite materials."

QI AN, doctoral student, conducted surface characterization research for this study as part of an ongoing international collaboration with researchers in Australia.

- Carbon nanotubes functionalized using novel ozone-based process.
- Model glass–epoxy–nanotube interphases created for surface characterization.

Chemical Engineering Journal 269 (2015) 121–134. http://dx.doi.org/10.1016/j.cej.2015.01.093 | Funded by National Science Foundation CAREER Award. Qi An's study abroad was funded by UD's Institute for Global Studies' Global Exchange Program.



Composites and Advanced Materials at a glance

Research in advanced materials aims to accelerate the pace of discovery, deployment and recyclability of material systems. Composites—hybrids formed by combining two or more materials—can be tailored to optimize their properties to suit desired applications, offer performance advantages (e.g., stronger and/or lighter) and incorporate multiple functionalities in contrast to traditional materials.

Areas of Expertise

- Stronger, more durable composite membranes for fuel cell hybrid vehicles and stationary power production
- Modeling and simulation for virtual composite manufacturing and process optimization for large-scale structures
- Multi-scale modeling of composite structure and performance (e.g., airplane fuselages, automotive hoods)
- Multifunctional composites for damage detection and structural health monitoring (e.g., pressurized tanks and bridges)

Affiliated Research Centers

- Center for Composite Materials (CCM)

Nanotechnology

New battery technology employs multifunctional materials

A team of researchers at the University of Delaware has discovered a "sticky" conductive material that may eliminate the need for binders.

BINGQING WEI, professor of mechanical engineering, and doctoral student **ZEYUAN CAO**, discovered that fragmented carbon nanotube macrofilms (FCNT) can serve as adhesive conductors, combining two functions in one material. Their work was reported in *ACS Nano*, a specialty publication of the American Chemical Society, and they have filed a patent application on the discovery.

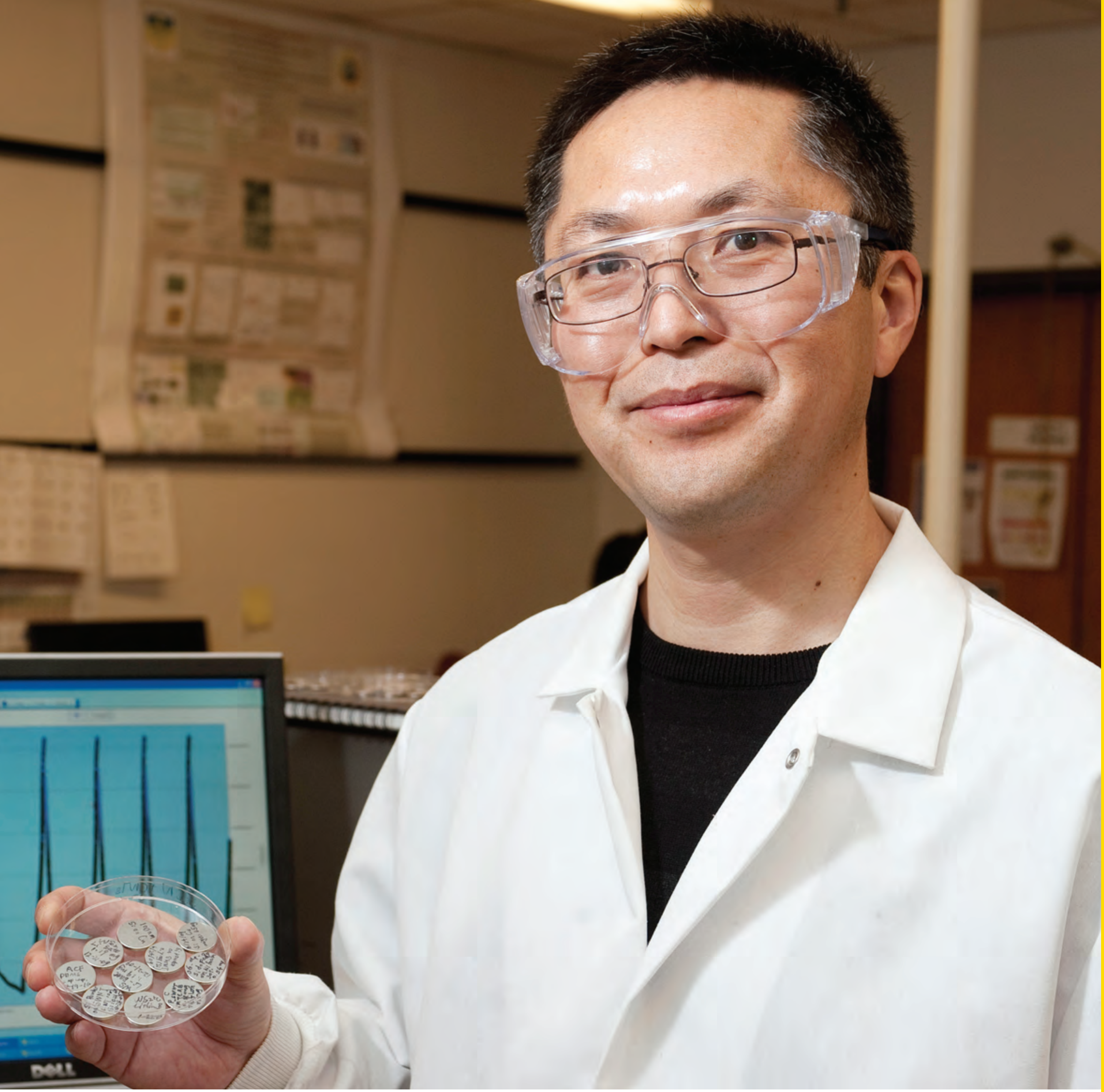
"The problem with the current technology is that the binders impair the electrochemical performance of the battery because of their insulating properties," said Wei. "Furthermore, the organic solvents used to mix the binders and conductive materials together not only add to the expense of the final product, but also are toxic to humans."

FCNTs are web-like meshes with "tentacles" that are coupled with active lithium-based cathode and anode materials. They are assembled using simple ultrasound processing. The process employs no organic solvents.

"We've found that the adhesive FCNT conductors actually have higher adhesion strength than PVDF, the binder traditionally used in lithium-ion battery manufacturing," Wei said. "We've also demonstrated that these composite electrodes exhibit higher electrical conductivity than traditional materials, and we've achieved these benefits in a low-cost green fabrication process that replaces toxic organic solvents with just water and alcohol."

ACS Nano, 8 (2014) 3049–3059.
http://dx.doi.org/10.1021/nn500585g
| *Funded by the National Science Foundation and the Research Fund of the State Key Laboratory of Solidification Processing, China.*

- Adhesive conductors have bifunctional roles as conductive additives and binders for lithium-ion batteries.
- The adhesive conductor is an efficient strategy to substitute conventional binders in the battery industry.



Nanotechnology at a glance

Nanotechnology is an emerging field that encompasses the manipulation of materials at the atomic and molecular scales (1–100 nanometers). This capability has enabled the development of new materials and devices that exhibit novel properties. Research in the department spans a wide range of topics, including processing, characterization and predictive modeling.

Areas of Expertise

- Synthesis and characterization of nanoscale materials (nanoparticles, carbon nanotubes, graphene) for durability, damage sensing and structural health monitoring
- Processing and characterization for manufacturing of flexible electronics and digital displays
- Scalable nanomanufacturing for battery and sensor applications
- Nanoscale transport phenomena to modify electrical and thermal properties of structures and components

Robotics and Controls

Robotics team studies flocking, formation control and path following of multiple vehicles

In the spring of 2011, an autonomous underwater vehicle (AUV) from UD's Coastal Sediments, Hydrodynamics and Engineering Lab directed by **ART TREMBANIS**, associate professor of oceanography, conducted sea bed surveys for habitat mapping in the Conch Reef off the coast of Florida. The vehicle used an on-board camera to create a mosaic of the ocean floor for the purpose of, among other science objectives, characterizing coral growth.

Robotics experts **LUIS ARIEL VALBUENA REYES, MME '12**, and **HERBERT TANNER**, associate professor of mechanical engineering, noted the scale of the overall area coverage achieved with a single AUV, as well as the particular pattern that oceanographers use to map the ocean floor using robotic vehicles.

Then they set out to develop control algorithms that would enable oceanographers to scale up such missions to fleets of underwater vehicles.

Valbuena and Tanner reported their new algorithms in the paper "Flocking, Formation Control, and Path Following for a Group of Mobile Robots," published last year in the *IEEE Transactions on Control Systems Technology*.

"Formation control algorithms that enable groups of autonomous vehicles to follow designated paths can be useful in mission planning and execution, both in the particular motivating application, as well as in a variety of other problem domains where robots are used for search and mapping," said Tanner, citing space exploration, search and rescue, environmental monitoring and surveillance among potential beneficiaries of their findings.

Their research includes a control architecture that coordinates a group of vehicles to fall into formation of a specified shape, flock and follow a predefined path, all at the same time through coexisting controllers that are implemented by concurrently evolving software processes. While centralized in principle, the architecture can be implemented in a decentralized way, depending on the nature of the graph that captures the communication topology between the vehicles.

The team concluded that a homogenous group of mobile robotic sensor platforms can be effectively coordinated to perform maneuvers required for search, coverage and mapping missions, as if they were a single, much larger, rigid structure. Composing such a structure out of identical modular components has advantages related to cost and robustness, they assert, since reconfiguration through relatively small software adjustments allows the deployment of such a group even when a few of its members become inoperable.

The motion control outlined in their paper brings together three distinct controlled mobility behaviors—namely, formation control, path following and flocking—into a single framework where all act concurrently, but in concert with each other.

"The overall architecture has proven effective both in numerical simulations, as well as in experimental implementation on a small group of wheeled mobile robots," Tanner said.

Working together with Trembanis, Tanner and **PRASANNA KANNAPPAN**, a doctoral candidate in mechanical engineering, developed a low-cost, small underwater remotely controlled robot as a testbed for prototyping and testing underwater imaging and automatic marine life detection systems. Their automated scallop detection algorithms, which are specifically designed to work under low lighting and visibility conditions, are documented in a recent article titled "Identifying sea scallops from benthic camera images," that appeared in the journal *ASLO Limnology and Oceanography: Methods*.

- Groups of mobile robots survey remote areas.
- New algorithms allow improved ocean floor mapping.

IEEE Transactions on Control Systems Technology, (2014). This article has been accepted for inclusion in a future issue of this journal and is published at http://dx.doi.org/10.1109/TCST.2014.2363132

Limnology and Oceanography: Methods, 12 (2014) 680-693. http://dx.doi.org/10.4319/lom.2014.12.680

Funded by the National Oceanic and Atmospheric Administration Research Set-Aside Program (autonomous underwater vehicle field effort) and the National Science Foundation (automated image analysis work).

Robotics and Controls at a glance

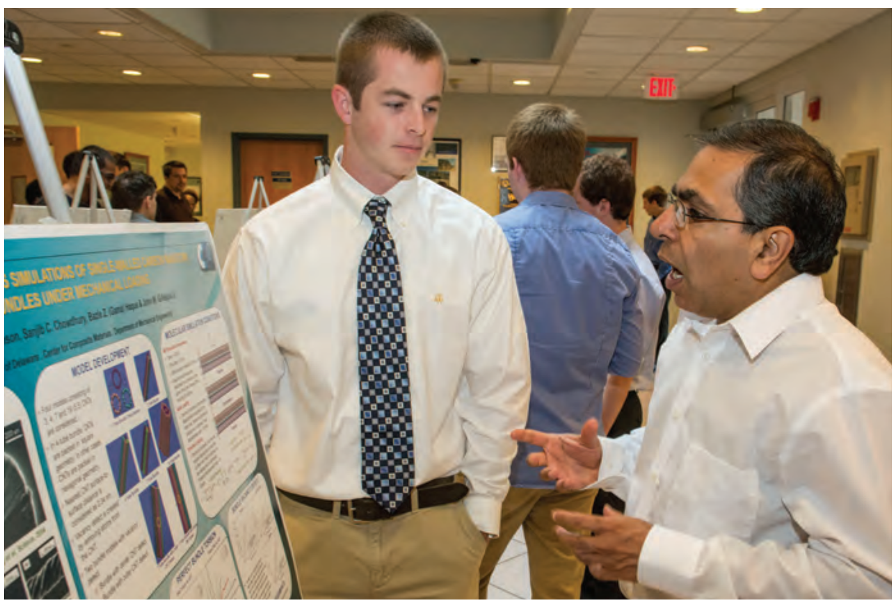
From the deepest oceans to outer space, robotic devices have been used in search-and-rescue missions, in environmental exploration and inspection, and in a host of other applications. Among the main motivations for designing, controlling and deploying robots is to replace humans in "dull, dirty and dangerous" jobs.

Areas of Expertise

- Robotic navigation and mapping for exploration and intelligence gathering
- Human-assistive technologies for the visually or mobility-impaired
- Robotic networks for cooperative active sensing in environmental monitoring and intelligent transportation
- New bio-inspired mobile robotic designs and control algorithms for emergency response and defense

"As I learn new and better things in my research, the next year I add that section in my teaching. I'm trying to introduce more lab experiments and computer simulations as part of the curriculum—as students do things, they learn much more. The future direction is more problem-based, hands-on learning."

– Suresh Advani



Advani hailed Composites Educator of the Year

SURESH ADVANI, the George W. Laird Professor and chair of mechanical engineering, has been named Composites Educator of the Year for 2015 by the Society of Plastics Engineers.

"Dr. Advani has created new courses and textbooks, developed physics-based modeling and simulation tools for composites manufacturing, and motivated and placed many students in the composite industry and academia," said **JACK GILLESPIE**, Donald C. Phillips Professor and director of the Center for Composite Materials (CCM), who nominated Advani for the award.

Advani researches manufacturing techniques for composite materials and formulates mathematical models to describe the material behavior by creating a virtual simulation of the process.

His Principles of Composites Manufacturing course allows students to model composite behavior with equations using software called Liquid Injection Molding Simulation (LIMS), which he's been developing and refining since 1992.

"Then they go in the lab and try to validate it and they see it actually works," he said. "That's how you get them to [understand] that there's science behind it."

"Suresh makes a concerted effort to transform laboratory findings into engineering applications," says **TSU-WEI CHOU**, Pierre S. duPont Chair of Engineering. "He has been a tireless leader in advocating the importance of engineering science-based composites manufacturing."

As well as teaching undergraduates, serving as department chair and associate director of CCM, Advani supervises 11 graduate students and runs professional education workshops—even summer programs for high school students—about composites manufacturing and simulation.

THOMAS CENDER, doctoral candidate at CCM, appreciates the personalized mentoring experience the professor and chair offers, and believes Advani's expectation that students do some experimental and some modeling work helps them become more well-rounded researchers.

In 2002, Advani and a co-author wrote the first comprehensive textbook on modeling in composites manufacturing, the second edition of which came out in 2012. Committed to open learning, Advani also created a video version of the composites manufacturing course, which has been taken by hundreds of students and professionals in the U.S. and abroad.

Mechanical Engineering Chair Suresh Advani has been named the Composites Educator of the Year by the Society of Plastics Engineers.

Burris awarded NSF grant to elucidate scaling effects in friction

A $300,000 grant from the National Science Foundation to **DAVID BURRIS**, associate professor of mechanical engineering, will support a controlled study of interfacial friction from the atomic scale to the practical scale. The results will help Burris—an expert in tribology, or the scientific study of friction—develop a testable model of frictional scaling, which is needed to inform materials design and surface engineering efforts for friction control applications.

"Although we understand that friction originates at the atomic scale, we lack the tools needed to quantitatively study how these interactions contribute to the generation of machine friction," said Burris who, with his team, has developed two key technologies to enable this project. The first is a method to reliably calibrate and quantitatively measure atomic-scale friction using atomic force microscopy. The second is a microtribotometer that can bridge measurements from the atomic scale to those from the macroscale.

"By making simple observations of friction across length scales, we hope to quantitatively link the friction we observe every day to its fundamental origins," he said. "Our long-term goal is to produce a testable theory of interfacial friction that our materials science collaborators can use to design materials and engineer interfaces for improved frictional control."

Engineering research aimed at environmentally sustainable building construction

A team of researchers at the University of Delaware has been awarded a three-year $300,000 grant from the National Science Foundation to address whether, and under what conditions, recycled steel can be safely reused, and lay the foundation for a new paradigm to reuse structural steel beams in contrast to recycling them.

ERIK THOSTENSON, assistant professor of mechanical engineering, is partnering with project lead **JENNIFER MCCONNELL**, associate professor of civil and environmental engineering, and **THOMAS SCHUMACHER**, assistant professor of civil and environmental engineering.

Thostenson pioneered the concept of carbon nanotube-based sensing skins for detecting deformation and damage in fiber-reinforced composites, and over the past several years, his research group has examined many aspects of carbon nanotube-based sensing under a variety of loading conditions. In this project, the researchers are investigating the use of smart sensing skins for monitoring construction-induced stresses in buildings.

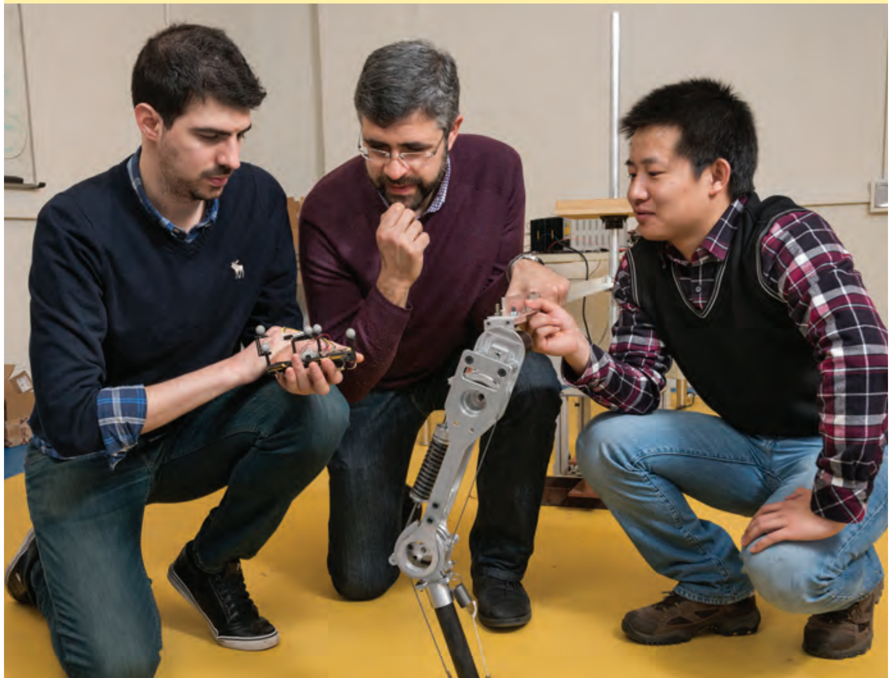
Poulakakis receives NSF CAREER Award to develop planning strategies for animal-inspired robots

IOANNIS POULAKAKIS, assistant professor of mechanical engineering, received the prestigious Faculty Early Career Development (CAREER) Award from the National Science Foundation to support his robotics research. Poulakakis is investigating ways to regulate the cyclic motion of legged robots so that they can perform tasks such as surveillance or exploration, jobs previously reserved for wheeled systems.

"Planning a robot's movements to achieve real-life tasks—such as search and rescue missions—is a key problem in robotics," said Poulakakis. "When it comes to legged robots, we know what controls can generate reliable locomotion, but how these controls are linked with higher level mission objectives is not well-explored."

He is particularly interested in the way an animal's limbs move during locomotion—a choreographed, cyclic motion that combines complex muscular planning, momentum and agility.

"We need to provide the necessary robotics science and technology to create dexterous, highly mobile legged robots that can autonomously plan actions in human-centric environments," he said.



Chou recognized with ASC/DEStech Award in Composites

The American Society for Composites recognized **TSU-WEI CHOU**, Pierre S. duPont Chair of Engineering, with the 2014 ASC/DEStech Award in Composites during the society's 29th Annual Technical Conference in September. A joint meeting between the ASC and the Japan Society for Composite Materials, the conference marked the continued collaborative research efforts between the United States and Japan. Chou, who joined the UD faculty in 1969, is known worldwide for his pioneering composites work.

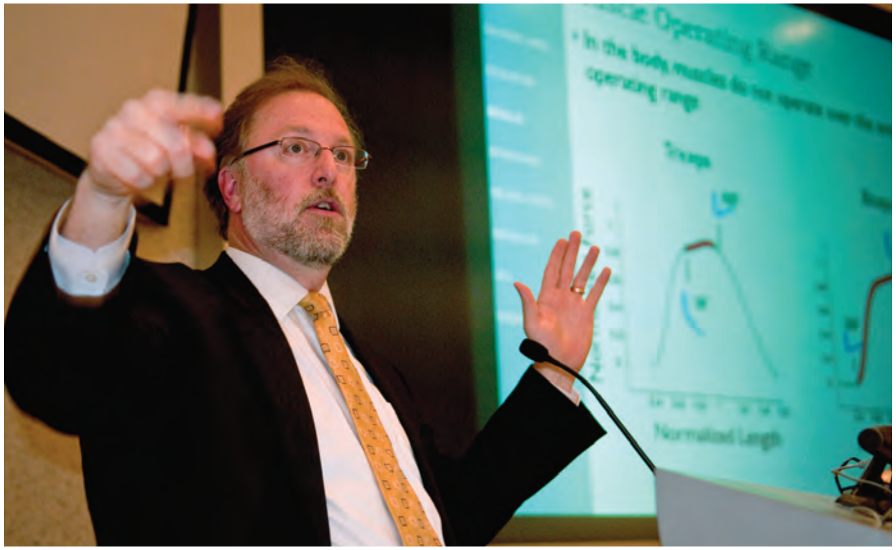
UDRF funding helps advance thermoelectric design

In his research titled "Designing nanostructures for advanced thermoelectric materials," **JOSEPH FESER**, assistant professor of mechanical engineering, will use funding from the University of Delaware Research Foundation (UDRF) to analyze the scattering of heat particles, called phonons, from embedded nanostructures to identify characteristics that will advance the design of thermoelectric materials with ultra-low heat flow for use in power generation and refrigeration.

NIH renews funding for osteocyte mechanosensing research

The National Institutes of Health has renewed a five-year $1.93 million grant to the interdisciplinary team of **LIYUN WANG**, associate professor of mechanical engineering, **X. LUCAS LU**, assistant professor, **CATHERINE KIRN-SAFRAN** from UD Biological Sciences, Cindy Farach-Carson from Rice University, and Sherry Liu from University of Pennsylvania, for their research on osteocyte mechanosensing.

Meet some of our Mechanical Engineering Faculty



Thomas Buchanan

George W. Laird Professor of Mechanical Engineering

Core Research Area: Biomedical Engineering

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 since1990—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 current 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.

Tsu-Wei Chou

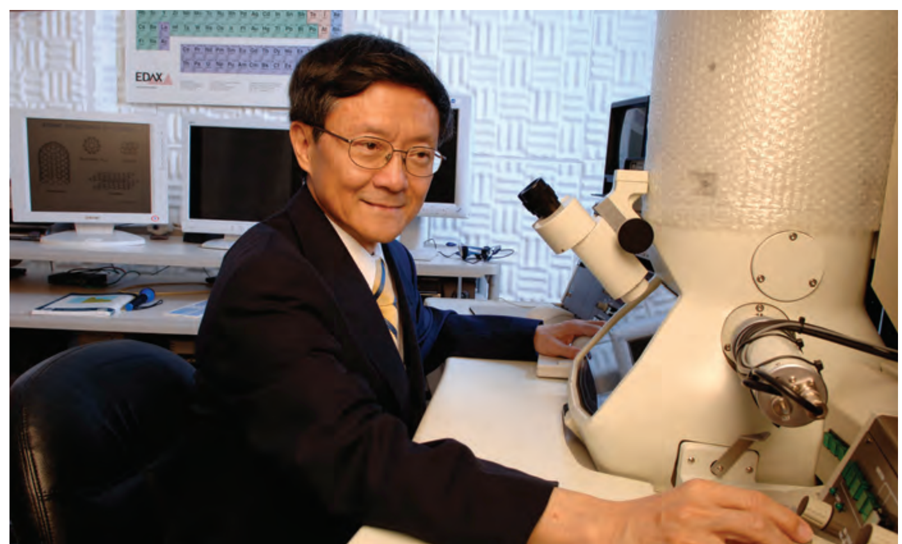
Pierre S. duPont Chair of Engineering

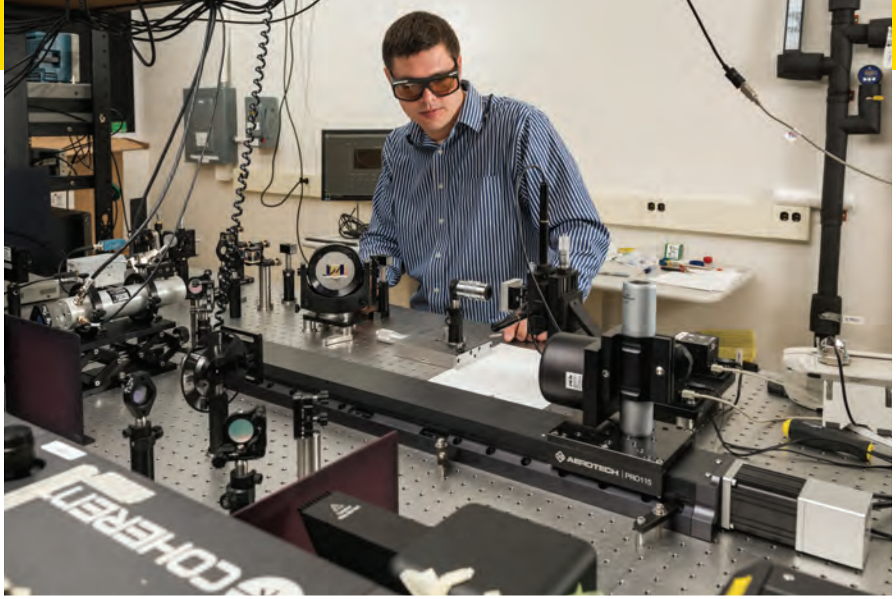
Core Research Areas: Nanotechnology; Composites and Advanced Materials

TSU WEI CHOU—considered a pioneer in the field of composite materials and named among the top 100 materials scientists of the past decade—has conducted research worldwide in the areas of materials science, applied mechanics, fiber composite materials, piezoelectric materials and nanocomposites.

His most recent work focuses on the development of advanced materials for use in supercapacitors. In one project, he demonstrated the use of graphene films, produced via chemical vapor deposition for this application. Due to their exceptional flexibility and transparency, CVD graphene films have been regarded as an ideal replacement of indium tin oxide for transparent electrodes, especially in applications where electronic devices may be subjected to large tensile strain. However, the search for a desirable combination of stretchability, and electrochemical performance of such devices, remains challenging. Chou and colleagues recently demonstrated the implementation of a laminated ultrathin CVD graphene film as a stretchable and transparent electrode for supercapacitors.

His team also successfully developed stretchable wire-shaped supercapacitors based on continuous carbon nanotube fibers. The remarkable stretchability was accomplished through a prestraining-then-buckling approach. The researchers reported a unique combination of outstanding electrochemical performance and stretchability with this type of supercapacitor. Their findings should facilitate the potential integration of wire-shaped supercapacitors with miniaturized and portable electronic devices.





Joseph Feser

Assistant Professor

Core Research Areas: Clean Energy and Environment; Composites and Advanced Materials; Nanotechnology

JOE FESER's current research focuses on the development of new thermoelectric materials, which can convert heat directly into electricity. A persistent challenge associated with thermoelectric materials is efficiency—if they could be designed to more efficiently convert heat into electricity, the door would be opened to a wide range of practical applications.

In Feser's MuTT (Microscale Thermal Transport) Lab, he and his students push the limits of heat transport through the development of extreme materials and new characterization tools for nanoscale thermal measurement, with an eye toward the creation of ultralow thermal conductivity materials that would raise thermoelectric efficiency.

One common strategy employed is the use of nanoparticles to scatter heat-carrying vibrations, known as "phonons." Feser's group is developing tools to study phonon scattering on its fundamental time and length-scale so that the size, shape and composition of nanoparticles can be optimized for thermoelectric applications.

The design of new materials that push the limits of achievable transport properties—thermal conductivity, interface conductance, heat capacity and thermoelectric power factor—will enable the development of new device technologies. Application areas include the cooling of electronic devices, thermoelectric energy conversion and next-generation magnetic recording devices.

X. Lucas Lu

Assistant Professor

Core Research Area: Biomedical Engineering

X. LUCAS LU and his collaborators are addressing several bioengineering problems. The first is prevention of post-trauma osteoarthritis (PTOA). 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 bisphosphonate in the treatment and prevention of PTOA. The drug is FDA-approved for the prevention of skeletal fractures in cancer patients and the treatment of osteoporosis. Lu is now investigating whether localized injection of zoledronic acid can prevent OA from developing in young patients without compromising the natural bone remodeling process.

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 lubricants for 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. Stem cells in the bone marrow generate new articular cartilage. Lu is working with physical therapists and orthopaedic 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

Assistant Professor

Core Research Area: Robotics and Controls

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 multi-agent systems.

Supported by a prestigious Faculty Early Career Development (CAREER) 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.

Ajay Prasad

Engineering Alumni Distinguished Professor and Director, Center for Fuel Cell Research

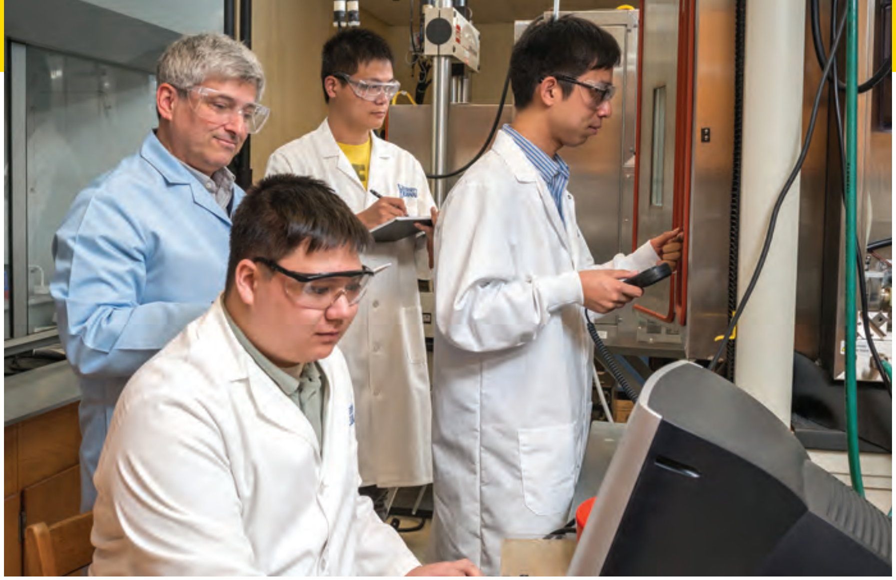
Core Research Areas: Biomedical Engineering; Clean Energy and Environment; Nanotechnology

AJAY PRASAD's leadership in the field of automotive fuel cells for transit applications has had worldwide impact and attracted significant interest from industry. He has devoted a major portion of his career to clean energy research. Other research interests include wind and ocean current energy, lithium-ion batteries, thermoelectric devices, vehicle-to-grid technology and solar thermal energy.

As director of the UD Center for Fuel Cell Research, he facilitates coordination among some 20 UD faculty members working in this area, as well as companies involved in fuel cells and hydrogen infrastructure activities. He also leads efforts to improve Delaware's hydrogen infrastructure activities as director of UD's Fuel Cell Bus Program, which currently operates two 22-foot hydrogen fuel cell-powered transit buses.

Prasad's lab is focused on improving the performance and durability of fuel cells for automotive applications. His fuel cell research spans the full range from the development and characterization of novel component materials—including membranes, catalysts, gas diffusion layers and bipolar plates—to system-level modeling, simulation and experiments, as well as accelerated stress testing. He has also made original contributions to renewable methods for hydrogen generation using solar-powered thermochemical cycles and solid-state materials and systems for automotive hydrogen storage.

Prasad serves on the University of Delaware Energy Institute's Council of Fellows and on the steering committee of the Center for Carbon-Free Power Integration, and chairs the UD Gamesa Wind Consortium Research Committee. He has played a vital role in the development of clean energy technologies at UD, and the promotion of clean energy in the state of Delaware.



Michael Santare

Professor and Director, Center for Biomechanical Engineering Research

Core Research Areas: Biomedical Engineering; Clean Energy and Environment; Composites and Advanced Materials

MICHAEL SANTARE joined the UD faculty in 1986 and served as director of UD's Orthopaedic and Biomechanical Engineering Center from 1993 to 1998. He was also a founding faculty member of the university's nationally ranked interdisciplinary Biomechanics and Movement Science graduate program.

In 2014, Santare was appointed director of UD's Center for Biomechanical Engineering Research (CBER). CBER fosters collaboration among students and faculty experts from all areas of biomechanics, including materials characterization, musculoskeletal modeling, device design, gait analysis and in vitro and in vivo studies.

Innovative CBER facilities include labs studying human performance, motion analysis, neuromuscular biomechanics, posture and movement biomechanics, and tissue engineering.

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 orthopaedic biomechanics.

Lian-Ping Wang

Professor

Core Research Areas: Biomedical Engineering; Clean Energy and Environment; Nanotechnology

LIAN-PING WANG's work in cloud physics bridges the fields of engineering multiphase fluid mechanics and atmospheric science. He collaborates closely with the climate science community, spending six weeks every year in residence at the National Center for Atmospheric Research in Boulder, Colorado.

He joined UD in 1994 and is currently studying the growth of cloud droplets in a turbulent environment, work that is enabled by recent advances in computational research tools and fine-scale instrumentation. He and his team have found that air turbulence can significantly enhance the growth of cloud droplets by collision-coalescence, the merging of two droplets into one larger droplet.

While visible clouds may extend over distances up to hundreds of kilometers, individual water droplets in a cloud are typically only 10–40 microns in diameter. The phase transformation between water vapor in the air and the liquid water in the droplets taking place at the droplet scale introduces bulk buoyancy effects that drive cloud-scale motion of 100 meters and larger.

Wang and colleagues began studying these complex multiscale and multiphase problems more than a decade ago, prior to the cloud physics community's broad acceptance of the quantitative impact of cloud turbulence on warm rain formation. Today, new parameterizations developed by his team motivate researchers to study the interactions of turbulence and inertial particles from a variety of perspectives.

Mechanical engineering hosts Toyota's fuel cell vehicle tour

Sales of Toyota's new fuel cell vehicle, Mirai, will begin later this year in California, where the infrastructure for hydrogen fueling already exists. But this past winter, University of Delaware faculty, staff and students got a sneak peak at the sleek sedan, whose name means "future" in Japanese.

A Toyota representative says the company selected UD for a stop on its Mirai Experience Tour because of the innovative research and development being performed in mechanical engineering's Center for Fuel Cell Research (CFCR).

UD's shuttle bus service has used fuel cell technology since 2007, with the fleet now including two hydrogen-powered fuel cell/battery hybrid buses that emit no harmful emissions. Two more fuel cell buses will be added to the fleet this year.

"Our goal is to educate the public that fuel cells are clean, safe and reliable and that fuel cell vehicles are easy to refuel," says **AJAY PRASAD**, College of Engineering Alumni Distinguished Professor and CFCR director. "It is necessary to get the public ready for the coming fuel cell automotive revolution."

Driving the research

Getting the public ready is just part of CFCR's work. Efforts are also aimed at improving the strength and durability of the polymer electrolyte membranes that lie at the heart of automotive fuel cells, as well as at addressing the challenges associated with developing the hydrogen infrastructure.

UD neighbor W.L. Gore and Associates—a world leader in fuel cell membranes—has supported membrane research at CFCR by **MICHAEL SANTARE**, professor of mechanical engineering.

"Fuel cell electric vehicles require light, powerful, reliable engines," says Gore's Simon Cleghorn. "We've been working on developing very strong and thin composite membranes that have enabled both very high power density fuel cell engines and long operational life.

"Over the past 10 years, we've collaborated with the Center for Fuel Cell Research in several areas," he adds. "One of the most important has been working to understand mechanical failure modes in polymer electrolyte membranes."

To address the infrastructure issues, CFCR researchers are working with scientists from Air Liquide—a major producer and supplier of industrial gases—that is on the forefront of hydrogen fuel cell technology.

"For fuel cell cars to become a reality, the challenges associated with developing the hydrogen infrastructure—including production, storage and delivery—will need to be resolved," Prasad says. "We have conducted research on the renewable generation of hydrogen from sunlight, as well as on novel strategies for improving the storage of hydrogen with solid-state

The Toyota Mirai fuel cell vehicle was showcased during a special event at UD, home of the Center for Fuel Cell Research. In the background is one of UD's two hydrogen-powered fuel cell/battery hybrid buses.

hydride materials. Both of these efforts have involved collaboration with Air Liquide."

From buses to cars

Prasad believes that a lot of the work done at CFCR is highly relevant to automotive fuel cells.

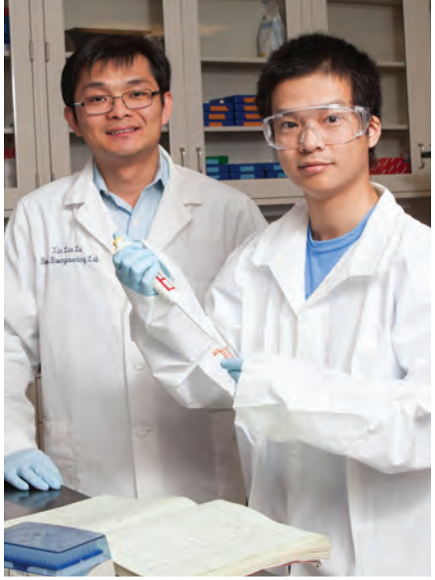
"We've conducted significant research and developed intellectual property in a number of areas including improved membranes, novel gas diffusion layers, cost-effective and durable catalysts, and improved balance-of-plant," he says. "Some of the fuel cell products we've developed are actually being considered for implementation by major automotive OEMs [original equipment manufacturers]."

"After decades of R&D and prototype development, fuel cell cars are finally on the threshold of commercialization," said Prasad. "With the announcement of the Mirai, Toyota is one of the first companies to sell cars to the general public. It's a major technological and commercial breakthrough and is very exciting to witness."

The Toyota Mirai fuel cell vehicle was showcased during a special event at UD, home of the Center for Fuel Cell Research.

"CFCR's work covers the entire spectrum, from membrane and catalyst research to fuel cell vehicle operation. This type of hands-on education provides students with the skills needed by industry and ultimately for fuel cell technology to succeed."

– Robert Wimmer, Director of Toyota's Energy and Environmental Research Group



UD graduate student receives ASBMR Young Investigator Award

A marathon runner himself, doctoral student **YILU ZHOU** is investigating new treatments for post-traumatic osteoarthritis (PTOA) with the hope of keeping severe osteoarthritis from sidelining fellow runners. His research on how zoledronic acid protects cartilage from traumatic-damage induced degeneration earned him a Young Investigator Award by the American Society for Bone and Mineral Resarch (ASBMR).

Zhou, who is advised by **X. LUCAS LU**, assistant professor, presented his research to an international audience of scientists and clinical investigators at the Bone Research Society's annual meeting in the United Kingdom last summer.

Two ME grad students named NSF Graduate Research Fellows; alumna earns honorable mention

ANAHID EBRAHIMI and **DIANA HAIDAR** have earned National Science Foundation Graduate Research Fellowship Program fellowships, Ebrahimi for 2015 and Haidar in 2014.

"Diana thrived at Wisconsin Madison, conducted undergraduate research and applied her studies for a few years in industry; the combination of the three is very rare," said advisor **DAVID BURRIS**, associate professor of mechanical engineering. She chose a program in which she could extend the metal-matrix nanocomposites research she began as an undergraduate; came up with and tested an original hypothesis; and demonstrated compelling proof of concept. This is a recipe for Graduate Research Fellowship Program success."

In looking for a Ph.D. research program, Haidar said, "Dr. Burris' research immediately grabbed my attention because his work in tribology resonated with my interests in designing materials for advanced performance for applications in extreme conditions." Haidar now also studies the tribology of polymer materials (such as nanocomposite PTFE), for which the Burris lab is already well known.

Ebrahimi, who analyzes the mechanics of unimpaired individuals, as well as those with lower-limb amputations ambulating under varying gait intensities, said she chose UD for the focus and resources being placed on biomechanics-related research: "I was impressed with the welcoming nature of the students, faculty and staff, as well as the interdisciplinary collaborations on research projects."

Ebrahimi is co-advised by **JILL HIGGINSON**, associate professor, and **STEVEN STANHOPE**, associate deputy provost for research and scholarship and professor of both mechanical and biomedical engineering as well as kinesiology & applied physiology.

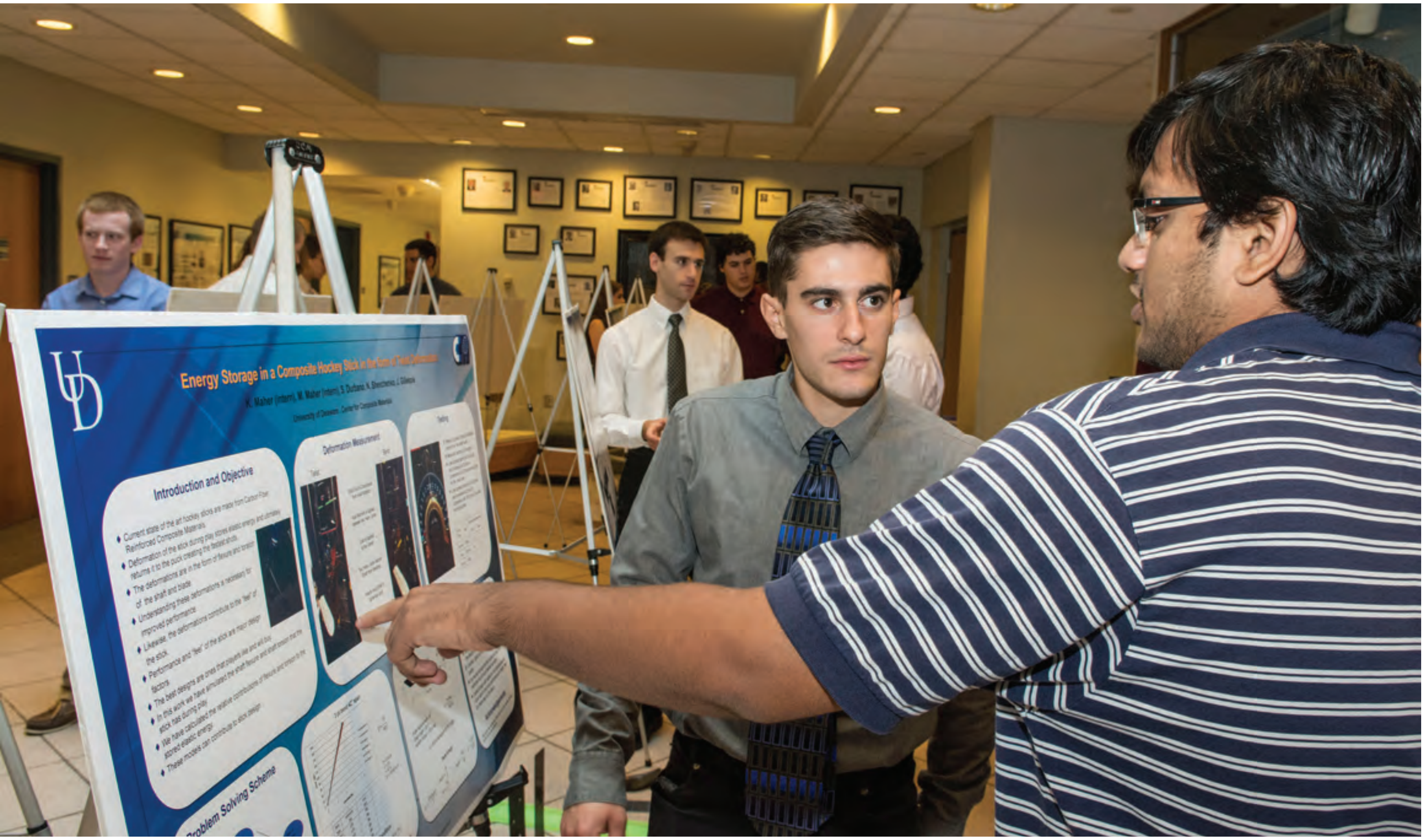
Higginson said Ebrahimi's research efforts bridge the areas of expertise of both advisors to ultimately understand muscle function and compensatory strategies available to amputees. "She has carefully conducted preliminary data collection and innovative analysis of the mechanics underlying body weight supported treadmill training, and built a musculoskeletal simulation to deduce the roles of primary muscles."

Added Stanhope, "Ana has remarkable capacity to apply engineering principles to better understand the human experience. Her contributions have been critical as we created a customized body weight support system and began testing patients."

Alumna **CHRISTINE GREGG, BME '14,** currently a graduate student at the University of California Berkely, received honorable mention. Gregg did her senior thesis under the advisement of **ERIK THOSTENSON**, assistant professor of mechanical engineering.

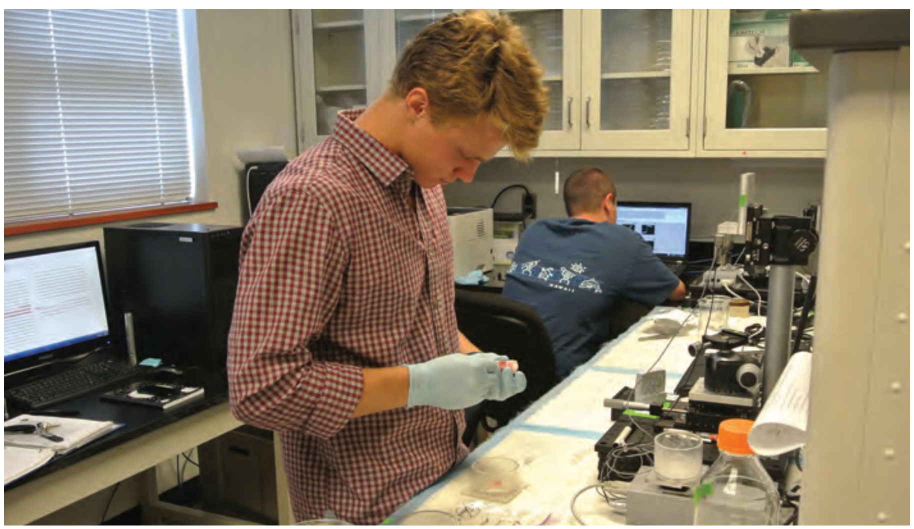
Diana Haidar

Ahahid Ebrahimi



Undergraduate research

Mechanical engineering has a long history of involving students in undergraduate research. Over the past year, many students have worked closely with faculty mentors within their research groups. Projects ranged from studying cartilage degeneration to using carbon nanotubes to detect cracks in advanced composites. Student opportunities this year included the Center for Biomechanical Engineering Research's Summer Undergraduate Research Fellowship (SURF), the Center for Composite Materials' Summer Intern Program and an NSF-funded Nanoscale Undergraduate Education (NUE) program.



Mechanical Engineering Lecture Series 2014–2015

Fall 2014

Jeffrey Morris
Professor and Chair of Chemical Engineering, **City College of New York**
"Examining the Influence of Inertia in Suspension Flows"

NOWINSKI LECTURE
Joost J. Vlassak
Abbott and James Lawrence Professor of Materials Engineering, **Harvard University**
"Nano-calorimetry: A centuries-old technique applied at the nano-scale"

Rod Borup
Fuel Cell Team Leader and Program Manager, Institute for Hydrogen and Fuel Cell Research, **Los Alamos National Laboratory**
"PEM Fuel Cells for Transportation: Design and Durability at the Microstructural Level"

Elise F. Morgan
Associate Professor, Biomedical Engineering and Mechanical Engineering, **Boston University**
"Failure Visualization and Failure Prediction in the Spine, Using Full-Field Displacement Estimation"

Yi-Xian Qin
Professor of Biomedical Engineering and Orthopaedics, **Stony Brook University**
"Bone Adaptation and Regeneration Regulated by Mechanotransductive Signals From In Vivo to In Vitro"

Spring 2015

Jayathi Murthy
Ernest Cockrell Jr. Professor and Department Chair of Mechanical Engineering, **The University of Texas at Austin**
"Fast Multiscale Simulation Techniques for Sub-continuum Transport"

Mark Campbell
Professor and S.C. Thomas Sze Director of the Sibley School of Mechanical and Aerospace Engineering, **Cornell University**
"Perceiving Complex Scenes for Autonomous Driving"

VINSON LECTURE
Arun Majumdar
Jay Precourt Professor of Mechanical Engineering and Senior Fellow, Precourt Institute for Energy, **Stanford University**
"Options to Create a Sustainable Energy Future"

Guoan Li
Associate Professor of Orthopaedic Surgery, **Massachusetts General Hospital and Harvard Medical School**
"ACL Reconstruction and Knee Biomechanics"

The NOWINSKI LECTURE 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.

The VINSON LECTURE series 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 nation in 1969, was the founding director of the University's Center for Composite Materials in 1974. He served as chairman of UD's Department of Mechanical and Aerospace Engineering from 1965 to 1979.

Mechanical Engineering Dissertations and Theses

Doctoral

Firat Cetinbas
"Modeling and Optimization of the PEM Fuel Cell Catalyst Layer"
(Advisors: Suresh Advani and Ajay Prasad)

John Gangloff
"Void Formation and Growth during Composites Manufacturing"
(Advisor: Suresh Advani)

Sahane Dattatraya Ganpat
"Wave Propagation in Microcrack-Damaged Media Under Prestress"
(Advisor: Michael Santare)

Harmandeep Khare
"The Coupled Effects of Environmental Composition, Temperature and Contact Size-Scale on the Tribology of Molybdenum Disulfide" (Advisor: David Burris)

Hossein Parishani
"High-resolution simulation of turbulent collision-coalescence of cloud droplets"
(Advisor: Lian-Ping Wang)

Hui Wang
"Solid State Hydrogen Storage"
(Advisors: Suresh Advani and Ajay Prasad)

Jiaxin Ye
"Characterizing PTFE Transfer Film Properties to Elucidate Transfer Film's Role in Ultra-Low Wear Sliding of Polymer Nanocomposites" (Advisor: David Burris)

Hang Yu
"Development of Thermal Conductivity Enhancement Model for Three Dimensional Fiber Composites"
(Advisors: Suresh Advani and Dirk Heider)

Qing Zhang
"Durability Study on Carbon Materials Based Electrochemical Capacitors"
(Advisor: Bingqing Wei)
Winner of the Allan P. Colburn Prize for best Ph.D. Dissertation Award of 2014 in the Mathematical Sciences and Engineering

Master's

Regina Adeleye
"A Study of the Effect of Bone Cell Conditioned Media on Triple Negative Breast Cancer Cells in Bone Microenvironment"
(Advisors: Jill Higginson and Anja Nohe)

Amy Bucha
"The Trade-Off Between Hip Flexors and Ankle Plantar Flexors Due to Age and Speed" (Advisor: Jill Higginson)

Gerard Gallo
"Characterization of the Electrical Response of Carbon-Based Fiber-Reinforced Composites for Damage Sensing" (Advisor: Erik Thostenson)

Reza Khoeilar
"Changes in Muscle Coordination of Stroke Patients Due to Robotic and Body Weight Supported Treadmill Training"
(Advisor: Jill Higginson)

Yan Liu
"Intrinsic Geometric Path for a New Kinematic Template"
(Advisor: Herbert Tanner)

Yuzhu Liu
"Role of Heat Pipes in Improving the Hydrogen Charging Rate in a Metal Hydride Storage Tank"
(Advisors: Suresh Advani and Ajay Prasad)

Fang Ruan
"Modeling PEM Fuel Cells Catalyst Layers"
(Advisors: Suresh Advani and Ajay Prasad)

Kelly Seymour
"Using Kinetic and Kinematic Parameters to Explain Changes in Gait Due to Cognitive Tasks"
(Advisor: Jill Higginson)

Philip Zandona
"The Effects of Changing Deposition Conditions on the Similarity of Sputter-Deposited Flurocarbon Thin Films to Bulk PTFE"
(Advisors: David Burris and Joshua Hertz)

Design Studio 2.0

Art and engineering integrate design to re-imagine Design Studio 2.0

Companies like Apple are well-known for their focus on technology, as well as the overall user experience in their products. This interplay between form and function is a crucial element in product design.

"As engineers, we tend to focus our creative energy on making things work," said **JENNI BUCKLEY**, assistant professor of mechanical engineering. "Artists have a different perspective since their focus is more on the interaction with the user."

With this in mind, Buckley and **DUSTYN ROBERTS**, assistant professor of instruction in the Department of Mechanical Engineering, teamed with **ASHLEY PIGFORD**, associate professor of art, to create a new technical elective focusing on integrated design, which also counts towards the new integrated design minor. By bringing art and engineering students together in the Design Studio, students learn to take a more holistic approach to designing products.

"For integrated design, each team is made up of engineering and art students," said Roberts. "By learning to function in multidisciplinary teams, students are better prepared for real-world product design and learn to appreciate and respect each other's perspective and skills."

Students' first challenge was to utilize their design skills to re-imagine the current Design Studio space into *Design Studio 2.0*.

The groups came up with innovative design solutions, such as smart storage systems—where tools can be checked-out using a smartphone app—to fully customizable rooms that can be rapidly reconfigured depending on project needs.

In the second phase of the class, the teams are working directly with Delaware-based Speakman Company, a long-time senior design sponsor, in developing concepts for innovative plumbing fixtures.

"These mechanical engineering students have been working in the Design Studio for the past few years as we have expanded the space and have seen the 'growing pains' firsthand," said Buckley. She credited the art students, who were new to the space, as able to look at it with fresh eyes and offer suggestions the engineers may have overlooked.

New York Times highlights UD for putting the art in STEM

Mechanical engineering's integrated design program, which promotes interdisciplinary collaboration between engineering students and those from other disciplines, such as art, was featured in the October 2014 *New York Times* article, "Putting Art in STEM," quoting both **JENNI BUCKLEY**, assistant professor of ME, and **DOMENICO GRASSO**, provost.

Like Leonardo da Vinci, who seamlessly combined engineering and art, said the article, UD's approach to holistic engineering allows students to cross disciplines to better understand—and design for—the human condition.

Describing the senior design approach, Buckley said, "Engineers focus on how it works. Artists focus on the user experience."

The article described a UD senior design prototype for a chest compression simulation device to replace mannequins during cardiopulmonary training. Wrote the reporter, "Art students made the device look more lifelike. Theater students, acting as patients, helped make it function more realistically."

"Learning to think like an engineer is very powerful," said Grasso. "But other disciplines also have very powerful approaches to thinking."

Read the full article at: http://www.nytimes.com/2014/11/02/education/edlife/putting-art-in-stem.html

Student-designed Simutrach prototype attracts industry interest, places first internationally

Every young inventor dreams of creating the next smart phone, social networking site or artificial organ.

For five UD engineering students, the dream came one step closer to reality when a representative of Laerdal Medical visited UD last summer to learn more about SimuTrach, a device they invented to provide realistic training for the care of tracheostomy patients. The team was also selected as the first-place technology innovation winner by the 15th International Meeting on Simulation in Healthcare Scientific Content Committee, which referred to the overlay system as "exceptional work."

An overlay worn by actors playing the role of patients in simulation training, SimuTrach is a new tool in UD's Healthcare Theatre Program, which helps health care professionals develop communication and treatment skills through interactive scenarios presented by theatre students.

Developed by an interdisciplinary team representing both mechanical and biomedical engineering, SimuTrach is currently on its third prototype, with each version offering improved features and functionality, from the lung sound to the skin feel. The team is now working on branding, pricing, identifying partners and creating a marketing plan.

"This project is a great example of what UD students can do," said **JENNI BUCKLEY**, assistant professor of mechanical engineering, who teaches the senior design course.

"They brought this idea all the way from a clinician's concept sketch to really mature, functional prototypes. They designed and ran clinical trials, which showcased effectiveness of the systems in training nurses, and they submitted the results for publication in a medical journal. Then they finished it all off by pitching their design to a major medical simulation company."

An actor wearing the Simutrach overlay with sensory feedback helps this healthcare student develop skill in treating tracheostomy patients.

Senior design team wins ASME Designing for the Future

Last summer, UD's Team Chesapeake, a mechanical engineering senior design team from fall 2013, won the first-ever ASME-Design Education Committee (DEC) Designing for the Future student competition at the 2014 International Design Engineering Technical Conference (IDETC) with a device designed to improve the testing of combat helmets.

The team was sponsored by Chesapeake Testing, an independent lab providing ballistic experimentation and non-destructive testing services for government and commercial organizations. Then-senior mechanical engineering students **TRISTAN ASSIMOS**, **KATHERINE BAGWELL**, **MICHAEL MECK** and **CHAD WILKINSON** (all BME '14) helped Chesapeake Testing test combat helmets as part of their senior design project.

The primary goals of the project were to create a device that was efficient, accurate, cost-effective and user-friendly. The students successfully created a device that allows for a helmet to be quickly marked with accuracy and precision to meet test specifications, and produces repeatable results.

Advised by **MICHAEL KEEFE**, associate professor, who is past president of the ASME-DEC, and Chesapeake Testing engineer **CAMERON SHOWELL**—an ME alumnus from the Class of 2010—Team Chesapeake was one of four teams chosen from entrants across the United States to participate in the competition held last summer in Buffalo. Keefe explains that what makes this competition unique is scoring not only by an evaluation panel, but by members of the audience, as well, on design methodology, team diversity and sustainability.

"Winning such a national competition offers recognition at a higher level and is an excellent way to showcase the talents of our senior design students," said Keefe, who particularly commends Team Chesapeake for pursuing this competition as it takes place the summer after graduation, so requires extra commitment on the part of the students. Assimos and Wilkinson represented the team in Buffalo at the competition.

"It's great to see them get the credit they deserve for really great design work," said Keefe.

Bridge team wins big at 2014 SAMPE conference

A team of seven UD ME students collaborating through the Center for Composite Materials (CCM) won big with four entries at last summer's Society for Materials and Process Engineering (SAMPE) international symposium in Seattle, finishing second overall and earning the following top division awards:

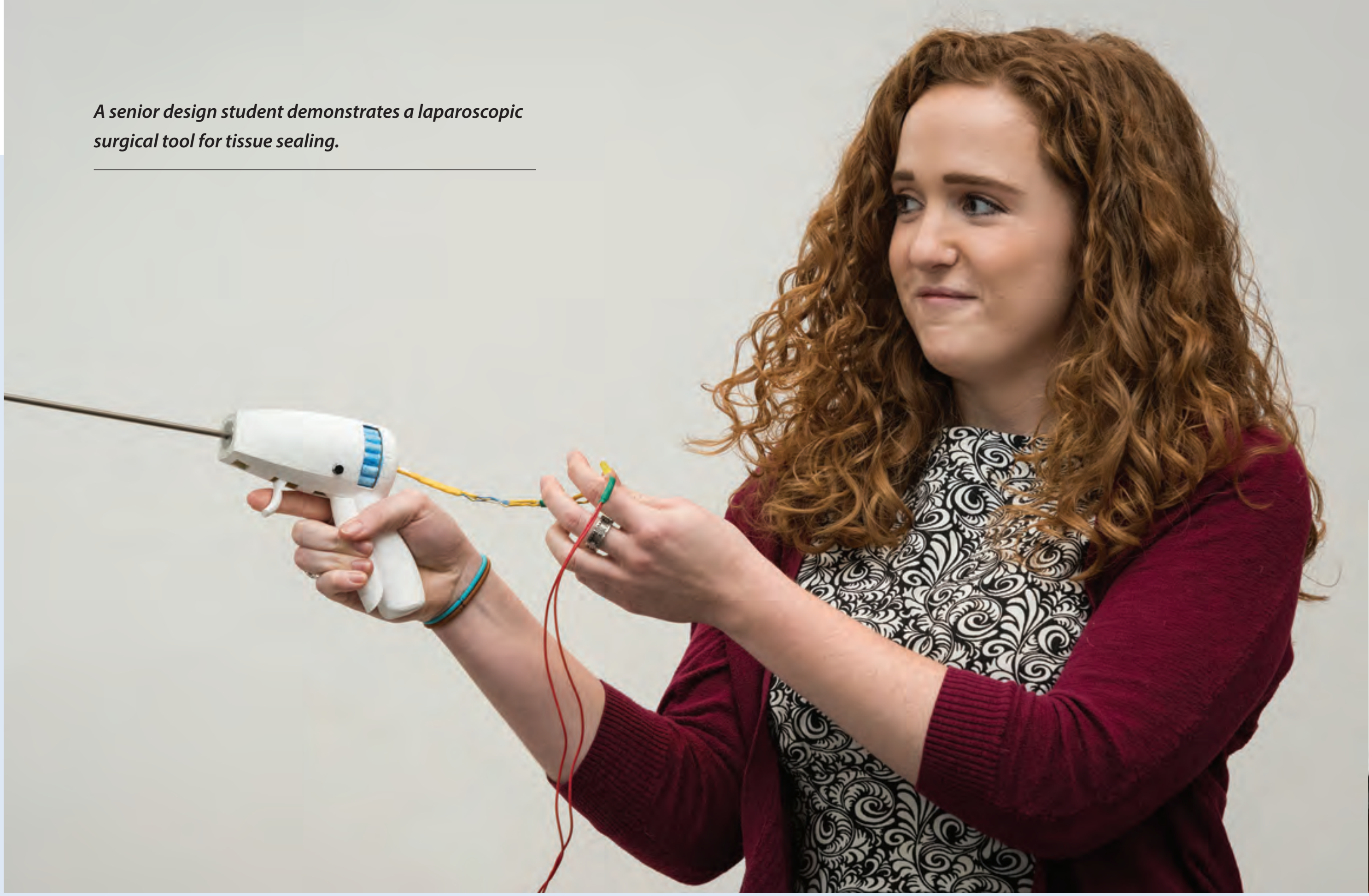
- 1st place: Carbon Fiber I-Beam
- 2nd place: Natural Fiber I-Beam
- 3rd place: Glass Fiber I-Beam
- 3rd place: Natural Fiber Box Beam
- 2nd and 3rd place: Beam Poster Competition

"This is one of UD's best showings ever, with success in both the academic and application-oriented aspects of the student competitions," said **ALEX VANARELLI**, president of the SAMPE-UD student chapter.

"We received tremendous support from CCM faculty and staff, the College of Engineering and SAMPE," he continued. "We also have access to a wide range of state-of-the-art equipment and materials here at the center. It's a great environment for carrying out these kinds of projects, and we continue to pass along what we've learned to the next generation of students through SAMPE."

Senior design prototypes lend realism to Healthcare Theatre Program

Many of this year's 20 interdisciplinary senior design projects focused on solving health-related challenges.



A senior design student demonstrates a laparoscopic surgical tool for tissue sealing.

Devices ranged from a heart model and an efficiency tracker for stair climbing to a pediatric exoskeleton and an interactive play gym that senses muscle activity. Other devices enable clinicians to remotely monitor a patient's condition and measure readiness to drive in patients recovering from lower-limb orthopaedic surgery.

Four teams added to the suite of tools for increasing realism in UD's Healthcare Theatre Program: SimuCath, a urinary catheter simulation; SimuThor, which guides post-op chest tube assessment and care; SimuShock, a defibrillation simulation; and SimuStick, which teaches proper intravenous needle insertion. All of the devices are wearable, with sensory feedback built in for the actors playing the role of patients.

LIYUN WANG, associate professor of mechanical engineering, worked with three of the Healthcare Theatre teams, including the group that developed SimuStick.

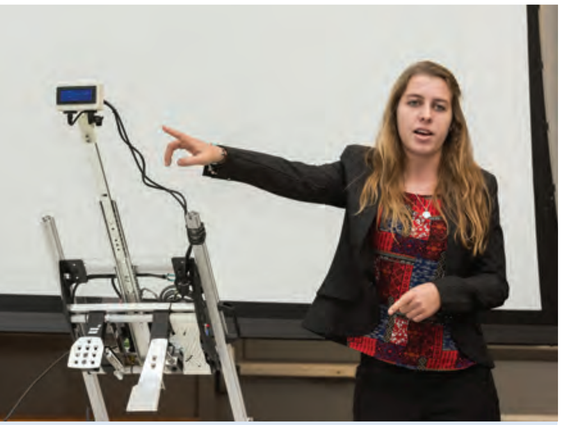
"They encountered a number of materials challenges in developing their product," she says. "Twice, they struggled for a week and then came up with an innovative solution. They did a great job, and now they're going to publish their approach."

One team created a minimally invasive vessel-sealing tool that incorporates an attachable extendable shaft and interchangeable tip sizes for use in laparoscopic surgery. Other projects were aimed at solving workplace ergonomic issues, including a machine that caps and uncaps sterile vials and tooling for a suture manufacture. Both devices seek to eliminate the need for injury-producing repetitive movement on the part of lab technicians.

"Most of the teams on these projects are actually designing for or working with human subjects," says **DUSTYN ROBERTS**, assistant professor of instruction in mechanical engineering. "One team even had their protocol approved by the IRB [Institutional Review Board] early in the semester, and they were able to run 30 subjects through their experimental protocol last fall."

"Engineers, in general, don't get experience testing devices on real people until much later in their careers, if at all," she said. "At larger companies or labs, the separation between engineers and end users is much greater than it is with our students."

Still other designs included a device worn by horses with restricted movement due to injury, a magnet-based socket system for a prosthesis, an MRI-compatible dynamometer, and a magnetic suspension system for lower-limb amputees that enables the user to attach and remove a prosthesis. Pediatric mobility projects include FUNctional Fashion, or garments



that children with arm movement impairments can inflate and deflate to assist them in moving their arms to better explore, play and learn.

"It's really quite amazing what our students are able to accomplish over the course of a semester," says **JENNI BUCKLEY**, assistant professor of mechanical engineering. "We've had sponsors come back to us and say that their teams have accomplished in four months what it takes them years to do. That's what we like to hear. We want our students to get their ideas out there."

Team QuadCrew's work highlighted at World Congress of Biomechanics

The innovative mobility-enhancing work of Team QuadCrew was highlighted at the 7th World Congress of Biomechanics Conference in Boston last July.

Working with the nonprofit Yes U Can, the interdisciplinary team of UD mechanical and biomedical engineering students developed a system that makes rowing crew possible for those with disabilities.

SARAH MASTERS, BME '14, now a UD graduate student and project mentor for Team QuadCrew, says the system is similar to the linear pull on a rowing machine at the gym. QuadCrew's prototype replaces the standard oar with two paddle wheels on each side of the boat and a pull bar directly above where the rower's feet are in the boat. The rower pulls linearly, allowing stability, while the linear pull system spins the wheels and translates to a rotational motion spinning the water.

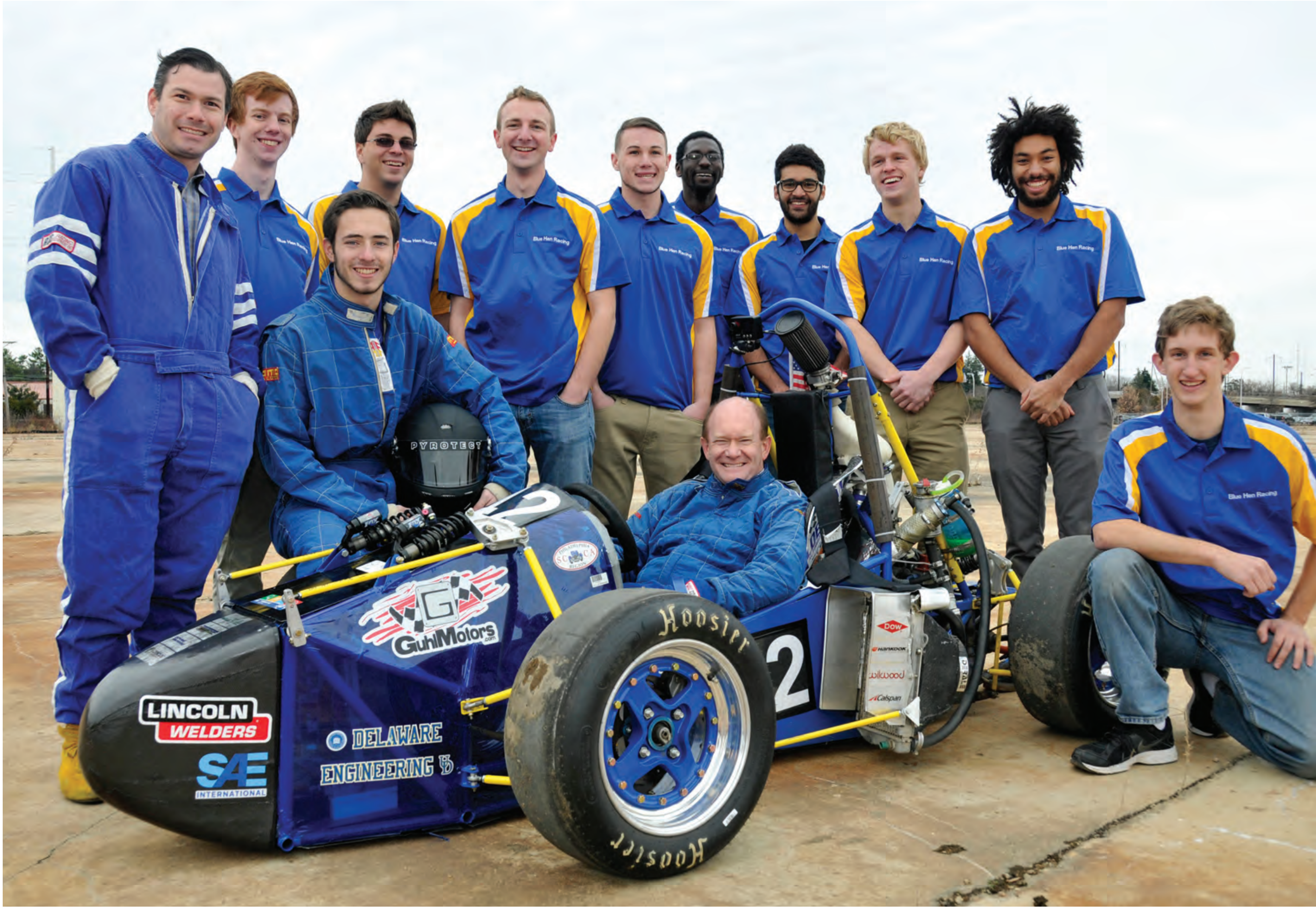
Masters and team also presented at the 2014 Clinton Global Initiative University conference.

Racing ahead: UD mechanical engineering students work with local group to develop biking devices

For the first three weeks of spring semester, sophomore mechanical engineering students in the computer-aided engineering design class taught by **JENNI BUCKLEY**, assistant professor, become bicycle mechanics. They patch flat tires and replace broken chains, grease wheel bearings and repair brake systems on a variety of bicycles under the guidance of volunteer mechanics at Newark Bike Project (NBP), a local nonprofit organization near campus.

Buckley's course shows students how to design a product with market appeal using the computer software SolidWorks, and then how to build a prototype to the software's specifications. By partnering with NBP, the students learn the skills needed to prepare for the design portion of their project—namely, how to assess a client's needs, how to develop an accessory to enhance a product or technology, and how to network.

"Encouraging students to be creative fosters entrepreneurial thinking, which is crucial to developing future innovative technology," she said.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Sen. Coons drives home importance of manufacturing skills

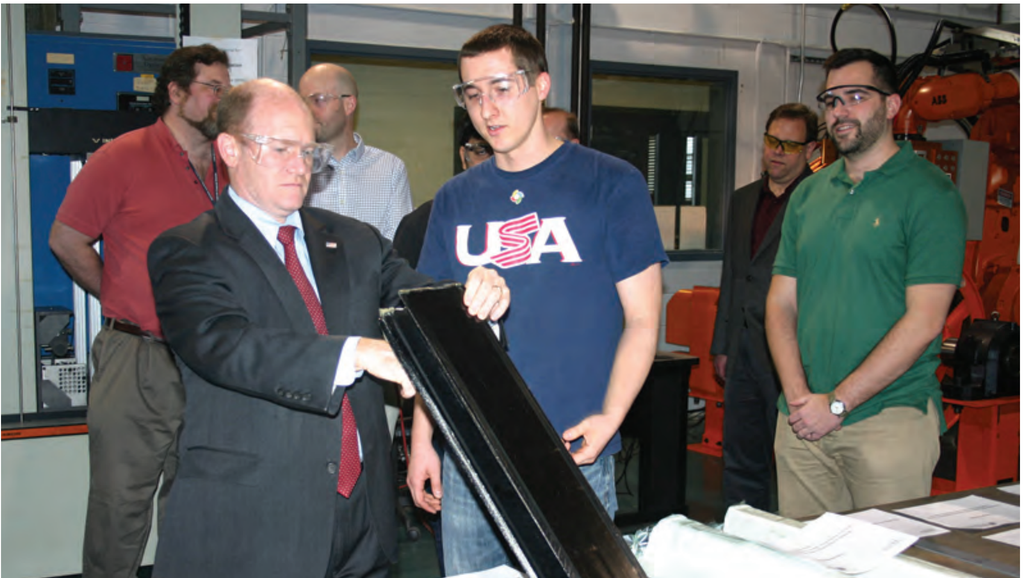
With mechanical engineering faculty and students cheering him on from the sidelines, U.S. Senator Chris Coons of Delaware took the wheel of Blue Hen Racing Car #42 last fall to demonstrate how curricula that offer students real-world industrial scenarios will help address the nation's surplus of unfilled manufacturing jobs.

"There are hundreds of thousands of currently unfilled high-skilled, high-wage manufacturing job opportunities in the United States," said Coons during his visit to promote the Manufacturing Skills Act, a bipartisan bill promoting education and skills-training reforms. "The University of Delaware has a great plan to meet those needs and this organization is just a piece of that plan."

His ride, Car #42, was built by the Blue Hen Racing Team, part of UD's Formula Society of Automotive Engineers Club as part of the collegiate design competition.

Coons returned to campus to tour UD's new Interdisciplinary Science and Engineering Laboratory (ISE Lab) and accept the Champion of Science Award from The Science Coalition, a nonprofit, nonpartisan organization of the nation's leading public and private research universities. **PATRICK HARKER**, UD president, and **CHARLES RIORDAN**, deputy provost for research and scholarship, presented the award recognizing Coons' strong commitment to funding the basic research that keeps the U.S. and the State of Delaware at the forefront of scientific and medical discovery and technological innovation.

And on a third visit to campus this spring, the senator visited UD's Center for Composite Materials to tour its advanced manufacturing capabilities. He learned about cutting-edge research ranging from robotic placement of composite layers to smart composites with integrated nanotube sensors.



"Sen. Coons understands that curiosity-driven scientific research, which provides the foundation for innovation and economic prosperity, is a public good that derives from the nation's research universities and national laboratories."

– **Charles G. Riordan, Deputy Provost for Research and Scholarship**

Career Celebration and Senior Appreciation Day

Hundreds gather to celebrate career success, applaud students at annual mechanical engineering gala

Keynote speaker Karen Fletcher, BChE '81, MChE '82, accepts an award of appreciation from Jim Hutchison, BME '78, MBA '82, of the Mechanical Engineering Alumni Relations Planning Team.

UD's John M. Clayton Hall was the place to be April 10 for mechanical engineering upperclassmen, alumni, faculty, parents and industry friends as they networked at one of the department's highlight events of the year—Career Celebration and Senior Appreciation day.

Hundreds joined **SURESH ADVANI**, department chair and George W. Laird Professor, to celebrate the career success of distinguished alumni and applaud the impressive achievements of the graduating class of 2015. The event was also an opportunity to acknowledge senior design capstone course industry sponsors. By providing real challenges for students to address, these companies offer students real-world experience in taking a project from "concept to reality," while guiding the design process. In return, sponsors appreciate the "fresh look" that the students bring to "old" engineering problems.

The department recognized four Distinguished Career Award alumni honorees—**PAUL COSTELLO**, **BME '66**, **THOMAS EMBLEY**, **BME '87**, **VANCE KERSHNER**, **BME '79**, and **BRIAN MURPHY**, **BME '90**—who shared thoughts in a panel discussion about how UD prepared them for career success.

Earlier in the day, returning alumni and parents toured mechanical engineering's specialized laboratories, including the unique new Design Studio "hacker space" learning environment that fosters interdisciplinary collaboration and hands-on research.

"Fabulous time to be an engineer"

To underscore its commitment to interdisciplinary collaboration, the department invited chemical engineering alumna **KAREN FLETCHER**, **BChE '81, MChE '82**, to deliver the keynote address. Fletcher, who is chief engineer and vice president of Engineering Facilities Services & Real Estate for DuPont, opened by saying that the current wave of baby boomers retiring, coupled with the creation of new jobs, makes this a "fabulous time to be an engineer."

Fletcher shared her own career journey, including how, at one point, she served as director and then vice president of Investor Relations at DuPont. How does a chemical engineer become a VP in a finance department? "That phone call came because of the different experiences that I had through my career," she said. "As a science company, DuPont had financial whizzes, but needed someone with a technology background and business savvy because investors ask a lot of questions about the R&D pipeline, our technology and why we're better than our competitor."

She imparted several pieces of advice to the audience:

- "Get connected. Do everything you can to build your network. Get a mentor. You'll be enriched by the connections you make."
- "Get out of your comfort zone. Try new things."

The 2015 Distinguished Career Award honorees shared career advice and UD memories during a panel discussion.

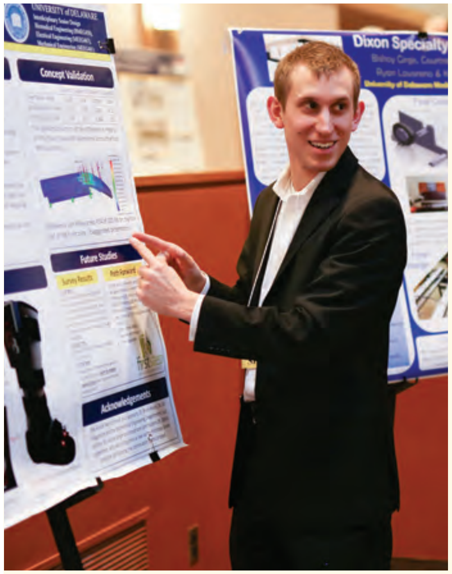
- "Be true to yourself. Know your moral center. Understand your strengths and capitalize on them; bolster where you have gaps. Do the right thing."
- "Stand up; speak up. Take an unpopular position; speak out for things you are passionate about."
- "Give back; pay it forward. You're blessed with skills and talent and the support system that got you here. Think about giving back—immediately. Get involved at work; give to your university; volunteer in your community. You will be better off for it."

Fletcher closed the evening with the following wisdom: "Keep going through those doors. Give it a shot. It's amazing to find yourself in places you never thought you could be," she said. "But most of all, give back."

Special thanks to the Mechanical Engineering Alumni Relations Planning Team for their work in pulling together another memorable event for the department.

"Keep going through those doors. Give it a shot. It's amazing to find yourself in places you never thought you could be. But most of all, give back."

– Karen Fletcher, BChE '81, MChE '82


Concept Validation
Future Studies
Acknowledgements
Dixon Specialty


Final Design
Prototype
Testing and Validation
Path Forward

Student Awards

Another highlight of the event was presentation of awards to the following mechanical engineering students in recognition of outstanding academic achievement:

Senior Awards

W. Francis Lindell Distinguished Senior Awards
Presented to **JOSEPH S. ESPOSITO** and **REBECCA L. RUNKLE**

Mary and George Nowinski Award for Excellence in Undergraduate Research
Presented to **MICHAEL E. SCHENK**

ME Alumni Outstanding Senior Award
Presented to **KELSEY A. DEVLIN** and **GARRETT R. SWENSON**

Junior Awards

W. Francis Lindell Distinguished Junior Awards
Presented to **HUNTER L. BACHMAN** and **MATTHEW J. HERSH**

W. Francis Lindell Mechanical Engineering Achievement Awards
Presented to **ROBERT L. HEEBNER** and **CINDY WENG**

ME Alumni Outstanding Junior Award
Presented to **THIEN-NAM D. DINH** and **MICHAEL A. TOWNSEND**

Departmental Awards

ASME Delaware Section Outstanding Student Award
Presented to **FRANCIS J. FISH**

ASME Student Section Award
Presented to **RYAN M. QUIRK**

Outstanding Student Leader Awards
Presented to **KATHRYN K. ORDEMANN** and **BENJAMIN L. BRUST**

Outstanding Student Service Awards
Presented to **ELIZABETH A. GORMAN** and **JESSICA E. PENMAN**

ME Alumni Outstanding Sophomore Award
Presented to **JAYANT E. RAO** and **RISHAY NATHOO**

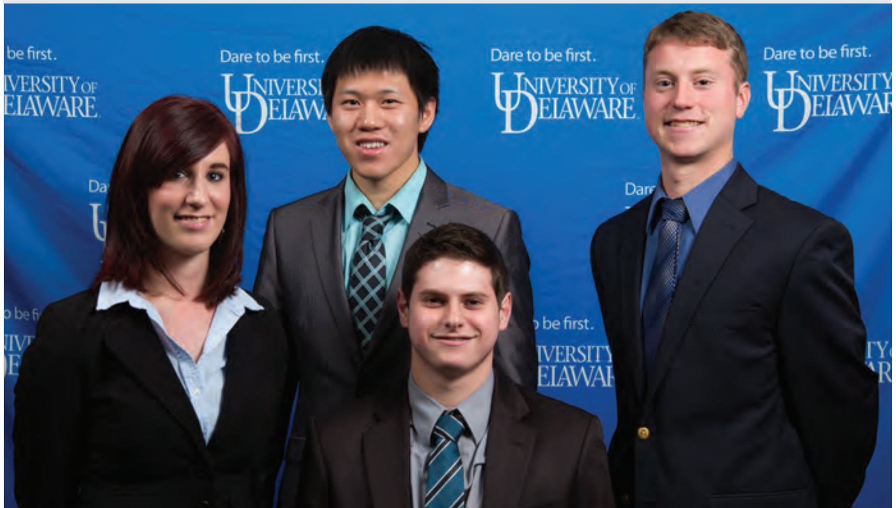
Graduate Achievement Award
Presented to **ANAHID EBRAHIMI**

Graduate Teaching Assistant Awards
Presented to **NATHAN M. GIGUERE** and **DIANA R. HAIDAR**

Undergraduate Teaching Assistant Award
Presented to **ADAM BITAR**

Senior Design

Two senior design teams—Team Southco and Team Hologic—were honored with the American Society of Mechanical Engineers (ASME) Outstanding Project Awards. Team Southco members **ZACH MARKS**, **TIM HEIDER**, **LOUIS AGOSTINO** and **CHRIS GREGAN** (below) were recognized for their work on an elastomeric latch fatigue test machine for Southco, producer of engineered access hardware solutions, based in Concordville, Pennsylvania. Team Hologic members **JENNIFER VITLIP**, **ZHENGYUAN ZHOU**, **ZACHARY PRESANT** and **ANDREW SKOCYPEC** (bottom) won for the bonded electronics peel tester they devised for the Newark, Delaware, office of Hologic, Inc., which develops, manufactures and supplies diagnostic products, medical imaging systems and surgical products used in women's health.



Congratulations

Paul N. Costello, BME '66

PAUL COSTELLO, who held several leadership roles throughout his career with DuPont, is now president and principal consultant for West Chester, Pennsylvania-based Evergreen Management Consulting, Inc., where he helps organizations develop successful strategies to deal with the challenges of business, environmental, competitive and regulatory issues.

Costello spent the first 18 years of his career serving in various technical services, sales and manufacturing positions throughout the U.S. In 1984, he was named president of DuPont Taiwan Ltd, where he held total corporate responsibility for the $125M/year subsidiary's sales, marketing, manufacturing and corporate offices.

As business manager for DuPont Specialty Services, he oversaw Safety & Environmental Consulting Services and Plastics Recycling; and as senior business consultant for DuPont Corporate Plans, he developed and implemented the corporate-wide process for helping more than 125 businesses achieve successful business and competitive strategies. In 1995, he was named global business director for DuPont Fluorochemicals, leading the turnaround of this $700M chemical business. In 1999, he became global business director of DuPont Solutions and Services, a large internal service organization of approximately 200 providing management and business consulting, sales and marketing training, communications and marketing research services, corporate customer care services to DuPont business and functional organizations.

Costello earned his bachelor's degree in mechanical engineering from UD and took courses toward an M.B.A. between 1968 and 1970. Says this chair of the Department of Mechanical Engineering Advisory Council to students and young alumni, "Don't forget to say thank you to those who help you along the way; there will be many. And don't forget to give back to those organizations that have supported you. My growth as a professional all started with my education at UD. Giving back has been extremely rewarding!"

Thomas C. Embley, BME '87

TOM EMBLEY recalls an "aha" moment in senior design class when he realized how all the skills he had learned over the last three years were helping his team make the correct business and engineering decisions. "I realized just how powerful our education was," he recalls, adding that the problem-solving skills he learned at UD have been incredibly helpful in solving design problems, business issues and general life challenges.

A dedicated and field-proven professional with a strong background in all aspects of business ownership, management, operations, research and development and administration, Embley has years of successful experience leading productive teams, implementing profitable initiatives and fostering

positive customer relations. He enjoys a solid reputation for resolving complex issues and understanding the "customer pain," and has been commended for his perseverance and efficiency, and leadership in business development, field development, executive team leadership, financial management and business growth. Today he uses those skills as co-founder and chief executive officer of the Newark, Delaware-based Precision AirConvey Corporation, a company focusing on developing matrix and trim handling solutions that ensure return on investment.

Embley began his career as a staff engineer with Precision Cutters Inc., helping them break into the industry as they built a new 5,000 square-foot facility; built the first in-line granulator and developed the tag line, "the leader in trim system design" as they became the top provider of trim system sales in the U.S. In 1995, he started AirConvey Systems, handling oversight of financials, heading up research and managing all sales and marketing.

He was president of the Lehigh Valley Chapter of the Pennsylvania Society of Professional Engineers and serves the Tag and Label Manufacturers Institute on both the annual and technical conference and environmental committees.

to the 2015 Distinguished Career Alumni

Vance V. Kershner, BME '79

Helping to make Delaware more entrepreneurial is one of **VANCE KERSHNER'S** passions. Following a 13-year career with DuPont, he formed the Wilmington, Delaware-headquartered LabWare, a global company with offices in 20 countries, employees in more than 50 and customers in more than 100. A "flat" organization along the lines of W.L. Gore (a LabWare customer), LabWare develops and implements software for automating laboratory operations. The company enjoys about 20 percent market share with annual sales over $100M in a niche market with about 50 competitors.

Kershner is also general partner in Leading Edge Ventures, an early stage venture capital fund focused on Delaware and the surrounding area, through which he has made a number of investments to get promising companies started and advises young companies on strategies based on his experience.

He expresses his engineering and artistic sides via special construction projects, including his own 100-year-old home on Wilmington's Kentmere Parkway, which he has painstakingly renovated; restoring the Oberod Estate in Wilmington and Buckley's Tavern in nearby Centreville, Delaware, and, a bit farther from home, operating a 15,000-acre game farm in South Africa (complete with botanical garden in the bush!). Protecting endangered rhinos is a particular interest, and Kershner is working with another UD graduate to develop drone technology to aid in this area. He is a partner in Scrub Island, the largest resort project ever undertaken in the British Virgin Islands; has an extensive art collection and is board president of the Mid-Atlantic Wine and Food Festival.

Dedicated to public service as much as to engineering and the arts, he is a member of the Board of Governors of the distinguished Jefferson Awards Foundation and leads the UD College of Engineering Advisory Council.

Brian K. Murphy, BME '90

As we all tuned in from the comfort of our living rooms for updates on airline tragedies over the last 15 years, **BRIAN MURPHY** was on the scene investigating the cause of the crash. Among the most notable, he had the solemn distinction of locating and recovering both the cockpit voice recorder and flight data recorder for highjacked United Airlines Flight 93, which fell to the earth near Shanksville, Pennsylvania, on September 11, 2001.

He also conducted the structural analyses and identified the cause for the in-flight separation of the vertical stabilizer of American Airlines Flight 587 which crashed in Belle Harbor, New York, in November of that same year, killing all 260 aboard the plane and five more on the ground. He successfully retrieved, in one piece, the Airbus A320 US Airways Flight 1549, which Captain Chelsey "Sully" Sullenberger landed on the ice-covered Hudson River in January 2009. In April 2013, Murphy was responsible for the wreckage recovery, structures investigation, cargo loading and cargo tie-down aspects of the investigation of the National Air Cargo B747-400 crash upon takeoff from Bagram Air Base, Afghanistan, which destroyed the plane and killed all seven crew members on board.

Prior to joining the National Transportation Safety Board and becoming the National Resource Specialist for Aircraft Structures, Murphy worked for Boeing in both the Commercial Airplane and Defense and Space Groups, Gulfstream Aerospace Corporation and Lockheed Martin Missiles and Space as a stress analyst, and with other companies as a stress analyst/strength checker.

Getting up to speed for a Mars landing

Editor's note: ***TOM FREY*****, BME '84, MME '90***, is a mechanical engineer at ATK Missile Defense and Controls in Elkton, Maryland. The business is part of ATK, an aerospace, defense and outdoor sports and recreation products company. Frey was lead engineer on a recent aerospace project designed to help NASA prepare for future missions to Mars. Here, he gives his account of the project. Since this article was written, ATK merged with Orbital Sciences and is now Orbital ATK.*

If you've seen reports or videos about a flying saucer in Hawaii, don't panic. It was just NASA getting us one step closer to landing humans on another planet.

On June 28, NASA successfully conducted a flight test of a low-density supersonic decelerator (LDSD) system from the Pacific Missile Range Facility on the Hawaiian island of Kauai.

The test program's purpose is to evaluate and demonstrate the effectiveness of two key elements—a supersonic parachute and an aerodrag device called a supersonic inflatable aerodynamic decelerator (SIAD)—in a new system for landing bigger payloads on another planet. The new system provides the capability of landing heavier payloads in preparation for NASA's future Mars missions, which may eventually include humans.

The flight vehicle was launched, or lifted, using a huge balloon, roughly the size of the Houston Astrodome, to achieve an altitude of about 120,000 feet. This altitude was necessary to perform the test in a thin atmosphere resembling that of Mars.

The vehicle was "dropped" from the balloon, and a rocket motor was fired to accelerate the vehicle to a high velocity (Mach 4) to simulate Mars entry conditions. After motor burnout, the vehicle was allowed to coast until its velocity decreased to a predetermined value before inflating the SIAD. Once the SIAD slowed the vehicle to the proper velocity (approximately Mach 2.5), the parachute was deployed, allowing the vehicle to splash down in the Pacific Ocean, where it was recovered for posttest examination.

ATK Missile Defense and Controls designed and manufactured the STAR™ 48B axial propulsion solid rocket motor that accelerated the test vehicle. The motor design is a variation of the Delta II third stage, which had more than 100 successful flights.

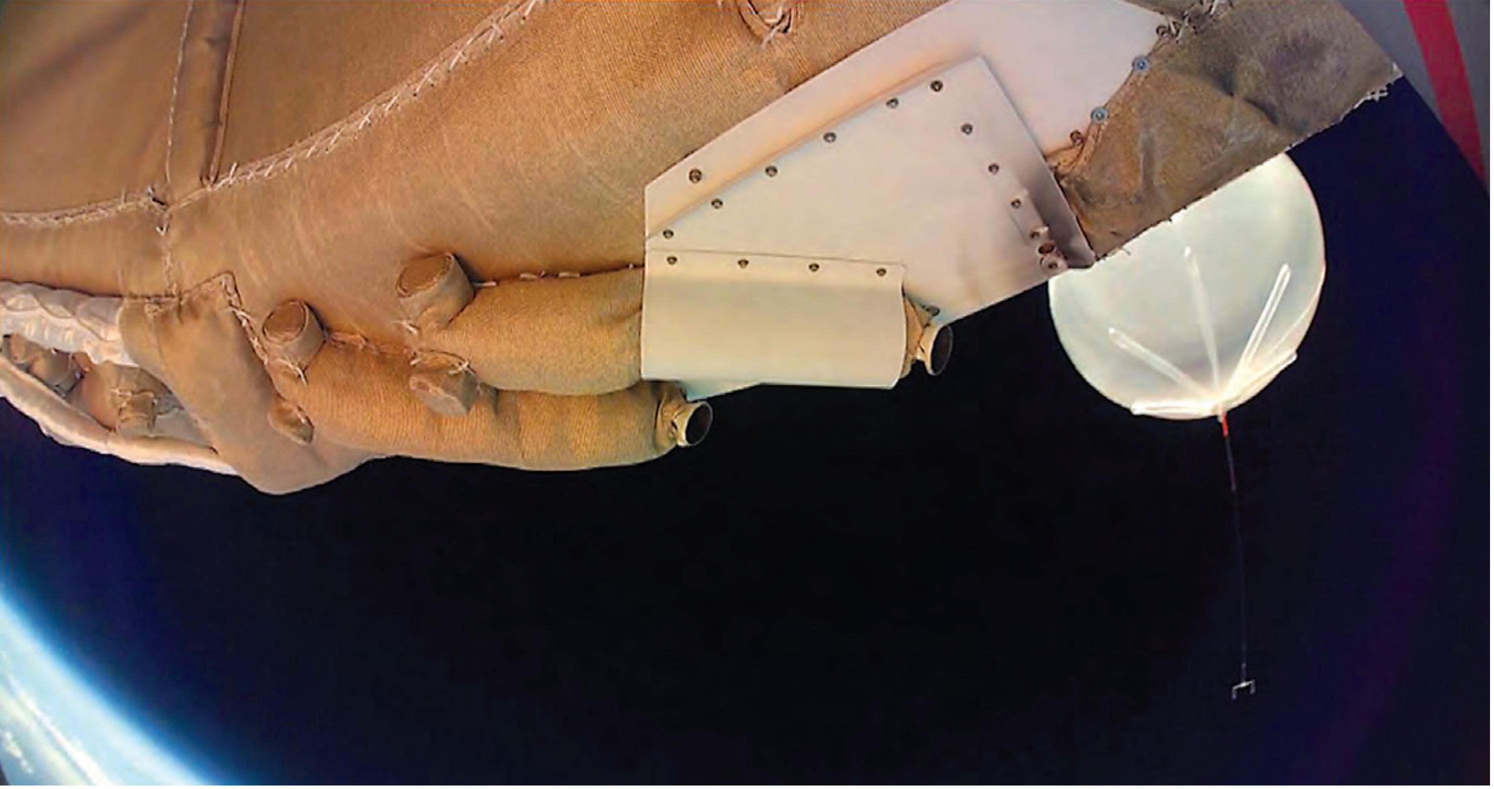
"This project once again demonstrates the high performance, reliability and versatility of ATK's STAR motor product line and also ATK's continuing commitment to supporting NASA missions," said program manager **JEFF BEMIS**, who earned his master's degree in business administration from UD in 2001. "It was the culmination of two years of good teamwork."

"From my point of view, as lead engineer for the project, this was probably the most unexciting 'countdown' ever. Instead of a typical '3, 2, 1 liftoff!' rapid acceleration event, it was '3, 2, 1,' followed by a two-hour slow balloon-ascent phase.

"Once it got to the desired altitude, however, the excitement started. The ATK motor, which was custom-designed to meet this mission's requirements, performed flawlessly to propel the system to the proper velocity. Basically, ATK got NASA's LDSD system up to speed.

"It made me think about **JACK VINSON** [H. Fletcher Brown Professor Emeritus of Mechanical Engineering], who supervised my master's degree research at UD. I remembered Dr. Vinson telling me about one of his early pioneering projects studying composite materials—before they were even called composite materials—for Earth re-entry heat shields. In a way, this project is a continuation of that work. But this time, NASA is focused on Mars."

ATK MDC employs many UD alumni, including **MIKE LARA, BME '82, MBA '84**, vice president of strategy and business development.



Left: Moments after the saucer-shaped test vehicle begins its rocket-powered flight, its camera photographs the balloon that carried it aloft. Below: Engineers unload the test equipment from a plane. Both photos by NASA/JPL-Caltech. Opposite page: Tom Frey on the launch pad. Photo courtesy of Tom Frey.

"ATK has long supported NASA with propulsion for space exploration initiatives, dating back to the Mercury, Gemini and Lunar Surveyor programs in the 1960s that paved the way for the Apollo missions, and more recently has supported science missions to the moon and Mars," said Lara.

"One of the more interesting aspects of this project is that our motors are being recovered and returned to us. This allows us the rare opportunity to evaluate a motor that has been flown in a space environment. Typically, our spent motors remain in space or are lost during re-entry."

The ATK Space Components division also supported the program by providing the composite core structure assembly that connected the motor to the vehicle. ILC Dover, in nearby Dover, Delaware, also played an important role in this project, providing the SIAD device that helped slow the vehicle to subsonic speeds.

Next, NASA's Jet Propulsion Laboratory will take time to fully evaluate and understand the data obtained from this first flight test and make any adjustments necessary.

Additional flights are planned, scheduled to begin this summer. NASA is targeting the next mission to Mars for 2020.

This article originally appeared in the University of Delaware Messenger, *Volume 22, #3, 2014*

UD alumna-led battery company secures $20M in venture capital; featured in *Wall Street Journal*

Sakti3, a Michigan-based company led by UD Mechanical Engineering Undergraduate DuPont Scholar **ANN MARIE SASTRY, BME '89**, has recently received $20 million in venture capital—$15 million from vacuum cleaner giant Dyson added to $5 million invested by General Motors and clean-tech investment firm Khosia Ventures.

Sakti3 ultimately hopes to deliver the next generation of batteries for electric cars. In the meantime, their solid-state rechargeable lithium-ion battery technology will supercharge 100 new machines for Dyson over the next four years.

"This is a very significant event for the company," said Sastry in an interview published March 15 in the *Detroit Free Press*. "Dyson is a multibillion-dollar global design, engineering and manufacturing company—and they have the will, the need and the capability to integrate our technology into their outstanding products and scale quickly." Sastry also discussed how Sakti3 is working to make electric vehicles more practical in a March 30 *Wall Street Journal* article.

Sakti3 was honored by MIT's *Technology Review* as one of the Top 50 Most Innovative Companies of 2012 for its technology and team. Their battery technology was also named one of the 2011 World's Top Ten Technologies, representing the energy category globally, by *Technology Review*.

Upon receiving a Distinguished Career Award from UD's Department of Mechanical Engineering in 2012, Sastry said, "I got a wonderful education at UD, and met my great friend and mentor, Professor Byron Pipes, who let me join his research group as a freshman—an experience that really shaped my professional future."

"I got a wonderful education at UD, and met my great friend and mentor, Professor Byron Pipes, who let me join his research group as a freshman—an experience that really shaped my professional future."

– Ann Marie Sastry, BME '89

ME's Kelly named to UD Alumni Wall of Fame

Mechanical engineering alumna **TERRI CONNOR KELLY, BME '83**, is among five alumni honored for outstanding accomplishments and inducted into the UD Alumni Wall of Fame during a June 2014 ceremony.

Kelly graduated summa cum laude, the highest distinctive honor. Shortly after graduation, she joined W.L. Gore and Associates and is now president and CEO of the company. In 2006, the Department of Mechanical Engineering selected Kelly for its Distinguished Career Award. She is a member of the University of Delaware Board of Trustees and a past member of the College of Engineering Advisory Council.

SURESH ADVANI, department chair and George W. Laird Professor, describes Kelly as a model alumna, always ready to help the department, the college and the university.

"Last year, despite her busy schedule, she accepted our invitation to be the keynote speaker at the annual Career Celebration and Senior Appreciation event," recalls Advani. "She shared her life journey, which was very engaging and inspirational, especially for our students. On behalf of mechanical engineering faculty and students, we congratulate Terri for the well-deserved honor of being named to the Alumni Wall of Fame, and look forward to her involvement with our department and the senior design program, of which she has been extremely supportive."

Alumna engineers love of classical music into successful career

ME alumna **ELSA CORNISH, BME '91**, spent her years at UD pursuing two favorite passions: her major, mechanical engineering, and minor, classical voice. Although she graduated magna cum laude and started her career as an engineer—first with DuPont and then with Exxon—for the last decade, this classically trained cross genre singer, songwriter and voice-over artist also known as Elsa Raven has performed to audiences in Tokyo, Morocco, Rome, Spain and Hawaii. She has also been a background vocalist for such artists as Belinda Carlisle, Gloria Gaynor and Michael Bolton.

Cornish recently reconnected with the Department of Mechanical Engineering, sharing, "My engineering educational and work experiences have definitely had a positive impact on my singing career, equipping me with the business and problem-solving skills necessary to succeed in any industry. I realize that my pursuit of a singing career would be unexpected given my academic background, but I have always had a love of music, classical in particular. I do miss the financial stability and affluence that an engineering career could have provided. However, my love of creating music and a flexible schedule outweighs those concerns."

Watch for this successful UD alumna on the New York music scene or follow her career on Facebook: https://www.facebook.com/elsaravencornish.

www.UDconnection.com

www.UDconnection.com allows you to search the alumni directory, post class notes, update your contact information and see if there are any upcoming alumni events in your area. You can also take advantage of networking opportunities and volunteer opportunities to get involved with your alma mater!

Carl W. Hall, MME '50

William H. Lotter Jr., BME '56

In Memoriam

The Department of Mechanical Engineering lost two of its Distinguished Career Award alumni honorees this past year. **CARL W. HALL, MME '50**, who won the DCA in 2006, died in April 2014. **WILLIAM H. LOTTER JR., BME '56**, honored with the DCA in 2011, passed away in January 2015.

Hall served as the deputy assistant director of engineering at the National Science Foundation from 1982 until 1990 where he played a major role in developing the new Engineering Research Centers program. While serving as acting assistant director for engineering, he worked with the White House Office of Science and Technology Policy, OMB, Congress, the National Academy of Sciences/National Academy of Engineering and numerous groups within NSF to mold this idea into a viable program to strengthen U.S. engineering research and education. The program represented a major change in the way NSF supported engineering research.

Hall received the Distinguished Service Award from NSF for his leadership and was recognized by the National Society for Professional Engineers as the NSF Engineer of the Year.

His research was in the areas of energy, drying, food engineering, properties of materials and biomass. He was a prolific author and founding editor of *Drying Technology: An International Journal*.

He served as president of the American Society of Agricultural and Biological Engineers and as director of the ASABE and the National Society of Professional Engineers, and he was active at the national level in ABET and the American Society for Engineering Education. He was dean emeritus of engineering and professor emeritus of mechanical engineering at Washington State University until 1982. He served three campaigns in the U.S. Army infantry with combat in the European Theater of Operations.

Lotter, who served on the ME Alumni Relations Planning Team, enjoyed a diverse career encompassing the paper, plastics and steel industries. He was one of the founding members and chaired Delaware Manufacturing Extension Partnership's board of directors, and he was a member of the manufacturing committee of the State Chamber of Commerce.

He engineered the startup of Specialty Composites Corporation, a manufacturer of polyurethane foam products utilizing a patented thin sheet casting process. He later served as vice president and general manager of Insteel Industries, transitioning the company from a financial loss position to a profitable wire mill until his retirement.

Upon acceptance of his Distinguished Career Award, Lotter said, "Besides the technical education I received at UD, the engineering curriculum taught me discipline and problem solving. Both can be effectively utilized in practicing engineering and management positions.

"Get involved and give back to the community," he advised fellow alumni. "Your career experience and problem-solving ability will help in your involvement and will be much appreciated."

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