

2014
NEWS

The Department of

Mechanical Engineering

MARK YOUR CALENDAR:

MAY 9

Mechanical Engineering
Career Celebration

See page 36 for details.

inside

Featured research:

fuel cells
robotics & control
composites & nanotechnology

Distinguished Career Awards | pg 37



College of Engineering

ON THE COVER: Mechanical engineering professors devise a system to detect radioactive material using quadcopters. Read more pg 18.



MESSAGE FROM THE CHAIR

Welcome to the 2014 Mechanical Engineering news magazine. It is my pleasure to share many exciting events and activities from the last year in the following pages.

In particular, I am delighted to report that, as promised, we have opened the first generation prototype of our Design Studio, which occupies 5500 sq. ft. on the first floor of Spencer Lab. We gratefully acknowledge our alumni who provided seed funding for this project, specifically Jim Foulk and Paul Costello, and Professor Jennifer Buckley, who used her creative ideas and boundless energy to work with our own ME students to design and build this version (read more on p 5).

The Design Studio puts us on the map as a leader in design education. We join a small group of schools—Stanford, Penn State, and Georgia Tech among them—that have invested resources in a physical space where students can brainstorm and launch design ideas. Our Design Studio represents the biggest per-student space allocation of any mechanical engineering program in the country. And we're not done yet. The Design Studio—like any design project—is a work in progress. We are continuously reshaping this space to better meet the needs of our program, our students, and our new interdisciplinary partners. I invite you to visit this space often, to see us grow and to join our efforts by giving your time, your expertise, and when possible, your financial contributions to this project.

Our faculty continue to make their mark in technologically important areas of energy, biomedical engineering, robotics, nanotechnology, and composites and materials through research publications and presentations. Last year, our 22 faculty published 138 journal papers in archival journals and gave 183 conference presentations and 75 invited presentations. Many were recognized for their work locally and globally. Professor Chou is the first UD faculty member to be awarded the Nadai Medal by American Society of Mechanical Engineers, which has over 100,000 members. Professor Gillespie, an alum and now an ME faculty member, was a co-recipient of Charles Pankow Award for Innovation. He also was elected a Fellow of the Society of Manufacturing Engineers and won the Boeing Performance Excellence Award. Professor Poulakakis was selected for the prestigious NSF Career Award and Professor Lu was selected for the Rising Star Award. The University honored Professor Ajay Prasad with a named professorship, appointing him a College of Engineering Alumni Distinguished Professor.

Our faculty continue to win grants nationally and internationally, with faculty research expenditures exceeding \$10 million last year. Projects range from zero emission fuel cell buses that run on campus to building creative robots that help stroke victims rehabilitate faster. Learn more about some important and stimulating research frontiers emerging from Spencer Lab on page 11.

This year marks the 40th anniversary of UD's world-renowned Center for Composite Materials (CCM). Created in Mechanical Engineering in 1974, CCM is a crown jewel of the College of Engineering. Professors Vinson and Chou, founding fathers of this center, continue to teach and conduct research in our department. Led by Prof. Gillespie, CCM continues to draw many visitors, sponsored research and industrial memberships. This year former department chair Professor Buchanan launched the Delaware Rehabilitation Institute (DRI), now located at the Science, Technology and Resource (STAR) campus on the former Chrysler site. DRI promotes high-quality interdisciplinary research within a scholarly environment that enjoins learning, discovery and community in rehabilitation practices. I am proud of the key leadership role our mechanical engineering faculty members have played in developing these successful interdisciplinary endeavors.

Last year's combined student Senior Appreciation Dinner and Alumni Career Celebration met with resounding success, bringing more than 300 students, faculty and alums together. The students eagerly listened as DCA panelists shared life lessons, their career path and the role mechanical engineering played in their success. Likewise, the alums were pleased to see the student projects and reminisce about their days on campus. I encourage you to join us for this year's event, scheduled for May 9 and coordinated by alum Nate Cloud and his team (Learn more on p. 36).

Many of the above initiatives are only possible thanks to the generous contributions of alumni, friends, faculty and staff. Your support enables educational programming improvements, top student awards and graduate fellowships. Thank you for supporting our department.

As always, please do not hesitate to contact us. We welcome your questions, concerns and suggestions.

Best regards,

Suresh Advani

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Looking for an old friend? Want to share your latest news? Searching for information on upcoming alumni events such as Homecoming? Now you can do it all in one place, www.UDconnection.com. UD and the UD Alumni Association (UDAA) have collaborated to bring alumni a vibrant online community—so register and get active! The online community 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!

Visit www.UDconnection.com today!



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Be sure to like the *University of Delaware* and the *Department of Mechanical Engineering* on Facebook!



DESIGN

STUDIO

Students take ideas to prototype in new Design Studio

The mechanical engineering department's innovative Design Studio allows students to take design ideas from concept to prototype in one convenient space.

Located in Spencer Laboratory and open to students around the clock, the studio includes four connected work areas designed to foster integrated learning: a prototyping lab, a collaboration laboratory, a materials repository and a machine shop.

The prototyping lab includes a 3D printer that can produce plastic parts for testing. It is connected to the collaboration laboratory, known to students as "the pit," which is the studio's communication hub.

The materials repository, filled with items commonly used for student projects such as nuts, bolts, plastic, metal and wood, sits

adjacent to a 2,318-square-foot machine shop where students build their designs.

According to Assistant Professor Jenni Buckley, the Design Studio is one of the most advanced spaces for undergraduate mechanical engineering in the country.

"Our Design Studio is the only space in the country created specifically for mechanical engineering students," she said. "It has two to three times the space of facilities at other institutions, allowing for creativity that I hope will produce even better work from our students."

In 2012, mechanical engineering students were involved in approximately five patents, a figure Buckley hopes to see grow. Future improvements to the space include connecting a testing room to the collaboration laboratory and purchasing new equipment to measure force, speed and distance.

"We just want bigger, bigger, bigger — more growth, more public awareness for the

awesome designs that are being produced by our students," said Buckley.

Department Chair Suresh Advani said he is excited about the benefits this facility can bring students, particularly in networking and job preparedness.

Scores of mechanical engineers—alumni, faculty, students and industry partners—gathered March 24 to officially dedicate the new facility and build awareness of and excitement for this evolving learning environment.

"Having a central space will create more connections between students and faculty, alums and industry," Advani said. "It will help students in their learning, connect them with alumni who stop by and facilitate one-on-one relationships with industry folks who visit, strengthening their job prospects in the future."

Adapted from an article by Kevin Cella

"UD's Design Studio is one of the most advanced spaces for undergraduate mechanical engineering in the country."

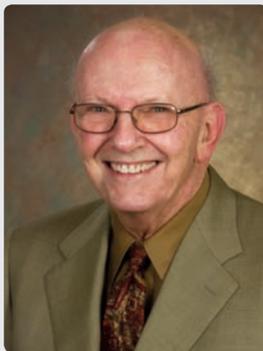
— **JENNI BUCKLEY**, ASSISTANT PROFESSOR
OF MECHANICAL ENGINEERING



The changing face of mechanical engineering

Long-time faculty members reflect on department's evolution as an academic powerhouse

Over the last half century, our nation has seen nine U.S. presidents, put a man on the moon and witnessed the birth of the internet and the rise of social media. During this time, thousands of students passed through the halls of Spencer Laboratory, home to the Department of Mechanical Engineering. We recently caught up with Jack Vinson and Mike Greenberg, veteran mechanical engineers with nearly a century of combined expertise, to ask them how the field—and the department—have changed over the last 50 years.



Jack Vinson, H. Fletcher Brown Professor Emeritus of Mechanical and Aerospace Engineering, came to UD in 1964 as associate professor of engineering mechanics in the Department of Civil Engineering. Just a year later, at age 35, he was named chair of mechanical engineering. Over the next 14 years, he grew the department from six to 14 faculty members.



Marking 45 years on the faculty, **Michael Greenberg**, now emeritus professor, came to UD in 1969. He was developing his research in naval hydrodynamics and UD had just become a Sea Grant Institution. For the last four and a half decades, Greenberg has taught applied mathematics at both the undergraduate and graduate levels.

Q: How has the field changed over the course of your career?

VINSON: Prior to joining the UD faculty, I led analysis of the structural integrity of the Minuteman ICBM State One Rocket motor—the first solid propellant rocket motor designed and fabricated in the USA—and helped the Navy develop an aircraft structure far less visible electronically, long before the word “stealth” was part of an engineer’s vocabulary.

In the early 60s, the only nonmetallic material used for structures was fiberglass. Because its material properties were so limited, it was imperative to optimize such structure for minimum weight, which also resulted in using sandwich

construction. Later in 1999, I was the founding editor of the *Journal of Sandwich Structures and Materials*.

Q: And how has the department changed during that time?

VINSON: In those days, UD had not yet earned the fine reputation it enjoys today, but all that began to change in 1959 when then-chair Jim Hartnett launched a seminar series bringing academic speakers to campus every Friday. Through this opportunity, we developed professional friends around the country. The department’s reputation was further forged in the 1960’s by a large NSF grant to build the mechanical testing and materials laboratory. It featured the latest technology could offer and attracted

visitors from several universities seeking assistance in their own proposals to government agencies.

The Department of Mechanical Engineering has never been stronger, more productive and more successful than it is now under the direction of Suresh Advani. Just one example of this: today four members of our department (Advani, Tsu-Wei Chou, Jack Gillespie and me) are editors-in-chief of international journals.

Q: When did UD’s reputation as a leader in composite materials come into play?

VINSON: In 1968-69, I taught UD’s first course in composite materials – and from what we know, it was only the

third such course taught in the USA. A year later, Tsu-Wei Chou, now the Pierre S. Du Pont Chair of Engineering, taught the nation's fourth course. Every year since, one or more courses in composite materials has been taught here.

In 1974, we formed the Center for Composite Materials. I was the first director from 1974-78 while chairing the department. The second director was Byron Pipes, under whose leadership the center flourished. It continues to do so today under the capable direction of Jack Gillespie and Suresh Advani, who serves as associate director, as well as chairing our department.

Ours was the first Center for Composite Materials in the world. Forty years later, during a recent review, a CCM visiting committee member described it as "the top nationally and internationally recognized academic research center for composite materials."

GREENBERG: Jack had the foresight to create CCM and it really put this department on the map. He deserves a great deal of credit.

VINSON: I consider the founding of the Center for Composites Materials my most important career achievement.

Q: How have the field, and department, evolved in terms of diversity?

GREENBERG: When I first came to UD, there might have been one female in a class of around 30 ME students. They tended to be among the best in the class, yet the "identity crisis" that they confronted as women in a man's field held them back, particularly at graduation.

Today, our female students not only excel during their tenure as students, but after graduation as well, both in academia and industry. A growing number of women now hold key COE faculty and leadership positions, including Kristi Kiick as deputy dean, and Dawn Elliott, director of biomedical engineering. Women currently comprise just under a fourth of COE's student enrollment and 17 percent of faculty positions.

Q: Has the material, or the way you teach, changed much over the years?

GREENBERG: Engineering has changed like a kaleidoscope, but the relevant mathematics has changed less. One major change in the teaching and studying of mathematics was the appearance in the 1980s of computer algebra systems, or CAS software, such as Maple, Mathematica and Matlab.

These are so powerful for solving mathematics problems that the question back then was whether they would, to a large extent, render the teaching of some 20 credits of mathematics unnecessary. I believe the answer, by now, is a clear: no, they have not – somewhat as a cookbook doesn't make a chef.

VINSON: How things change! In the 1960s, all male students were required to take two years of ROTC, all students were required to take a one-credit hour course called History of Delaware, and undergraduates were required to learn to swim in order to graduate.

As for the way we teach, who would have ever thought, back in those days, that when a professor retired, he or she could continue to teach effectively? Yet today, with the electronic prowess that exists, and thanks to the Engineering

Outreach group in the dean's office, I am still teaching all four of the graduate courses that I developed and wrote the textbooks for students both on campus and online.

Q: What advice do you have for today's up-and-coming engineers?

GREENBERG: It's essential to understand the role of language in doing mathematics. Words matter. I believe we—teachers and students—may be focusing too much on solution methodologies and too little on what it takes to put together a careful definition.

VINSON: Concentrate on mathematics, physics and design aspects in your curriculum. All other skills are easier to master later; these three are more difficult to pursue later.

Q: Please share a few favorite memories on your tenure with the department.

GREENBERG: I once handed the class *the solution key* instead of the exam! Other fond memories include going on caving and camping trips with grad students and faculty, and playing on an ME intramural softball team with after-game nachos at the Deer Park. I still have the cork from the bottle of champagne that Jack brought in so we could drink to my first book in 1971.

VINSON: Mine has been a most gratifying and happy career. Engineering continues to be the most stimulating, best choice for a career, no matter what you eventually do in your life.

FACULTY HIGHLIGHTS



NADAI MEDAL

Tsu-Wei Chou

Pierre S. du Pont Chair of Engineering, is the 2013 recipient of the American Society of Mechanical Engineers (ASME) Nadai Medal.

A pioneer in the field of composites materials, Chou was recognized for “seminal contributions to fundamental studies of anisotropic, heterogeneous material systems and nanocomposites; and for the combination of theoretical and experimental work that has enabled unique insights essential to the engineering of ceramic-, metal-, and polymer-based advanced composites.”

His expertise covers a wide variety of materials and geometries, including hybrid composites, textile structural composites, flexible composites and most recently nanocomposites. He and his research team have demonstrated unique applications of carbon nanotube-based continuous fibers in multifunctional composites and energy storage devices.

He is currently collaborating with researchers at the Korea Institute of Materials Science on a project to support research in advanced hybrid nano- and micro-composites for structural and multifunctional applications. Now in its third phase, the team is conducting fundamental studies of nano-carbon-based multiscale hybrids for multifunctional composites and energy storage devices through funding from the National Research Foundation of Korea.

Chou joined the UD faculty in 1969 and was a founding member of the Center for Composite Materials (CCM). He is credited with pioneering and sustaining many of the international collaborations that have earned CCM worldwide recognition.

Adapted from articles by Diane Kukich

“Congratulations to Erik Thostenson, assistant professor, who was honored with the 2013 **Outstanding McNair Faculty Mentor** award.”





NAMED PROFESSORSHIP

Ajay Prasad

Professor of mechanical engineering, is now a College of Engineering Alumni Distinguished Professor at the University of Delaware.

Prasad directs the University's Center for Fuel Cell Research, coordinating the efforts of approximately 20 faculty members and companies working to make fuel cell components and systems cheaper and more durable for large scale manufacturing and implementation.

He also leads efforts to improve Delaware's hydrogen infrastructure activities as director of UD's Fuel Cell Bus Program, which operates two 22-foot hydrogen fuel cell powered transit buses. His other research interests include energy-efficient buildings, wind and ocean current energy and vehicle-to-grid technology.

Prasad, who joined the UD faculty in 1992, is a fellow of the American Society of Mechanical Engineers, and a member of the American Physical Society and the American Society of Engineering Education.

"Ajay is an internationally recognized scholar whose research in applying fundamental fluids and thermal physics at the component and systems levels has resulted in significant contributions to the energy field. His leadership in developing initiatives and programs that address our nation's energy needs will continue to enhance the way we use energy technology in the future," said Suresh Advani, department chair.

Article by Collette L. O'Neal



EXCELLENCE IN ADVISING AND MENTORING

Jenni Buckley

Assistant Professor, was selected for UD's 2013 Excellence in Advising and Mentoring Award.

Recipients receive \$2,500 and are honored with an inscribed brick in Mentors' Circle.

Buckley described her perspective on advising and mentoring students saying, "Engineering is a combination of theory, practice and common sense. I think that every student whom I work with has the potential to be competent in all and

excel in at least one of these practices. In doing so, they will become a good professional engineer and make a meaningful contribution to society. I never think that a student cannot reach a particular milestone— whether it is making a novel design or understanding an engineering concept—and I like to think that my belief in them helps them reach their goal."

Research underpins every engineering innovation. It is the scientific foundation that transforms intellectually exciting ideas into pioneering discoveries.

UD researchers investigate problems from a variety of angles in order to develop viable solutions to problems impacting society.

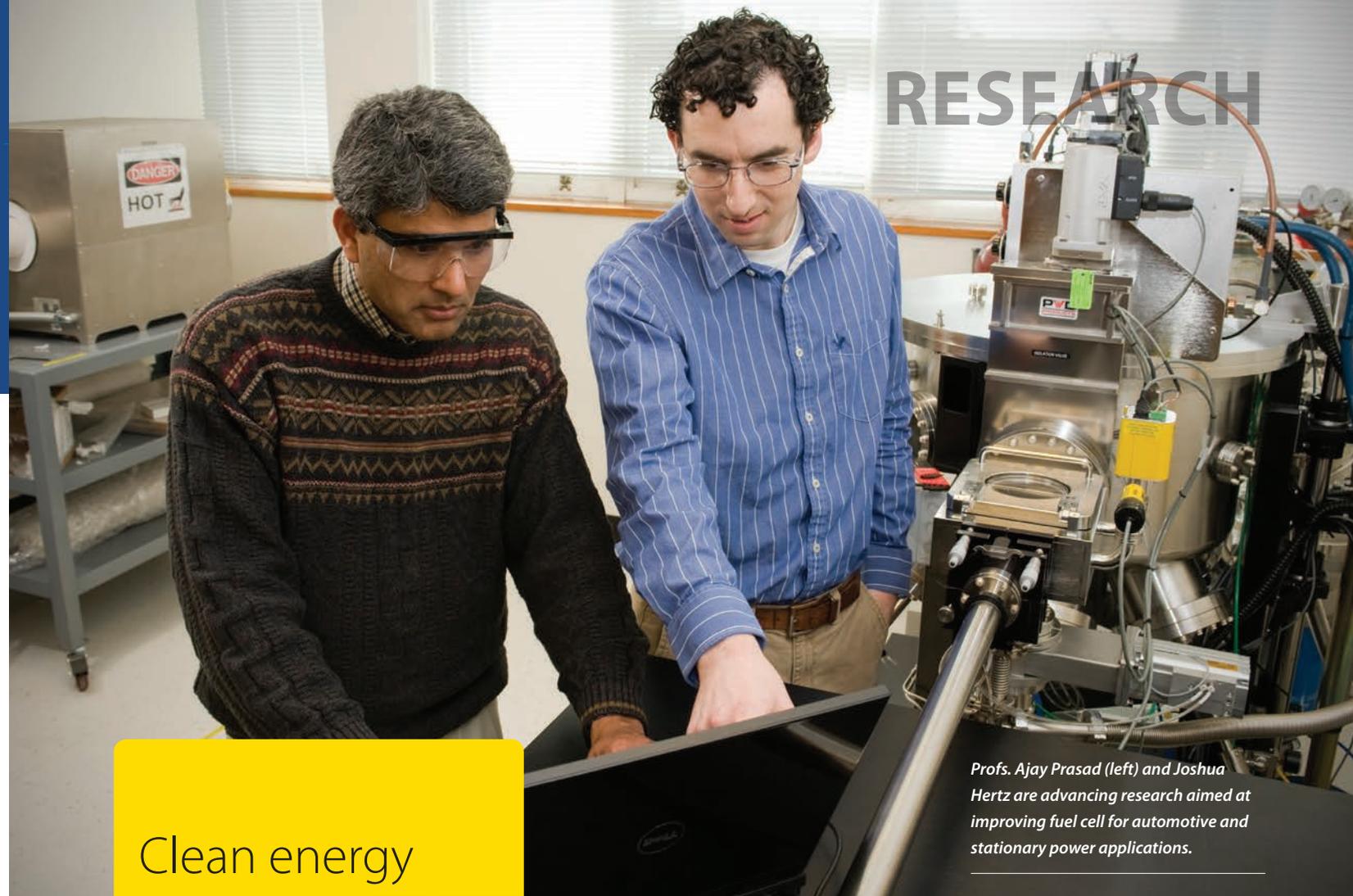
In the pages that follow, we offer a closer look at research within our department destined to help redefine and reshape our world.



Suresh Advani
Chair

Mechanical Engineering Faculty Research

		Biomedical Engineering	Clean Energy and Environment	Composites and Advanced Materials	Nanotechnology	Robotics and Controls		Biomedical Engineering	Clean energy and environment	Composites and advanced materials	Nanotechnology	Robotics and controls
Suresh Advani			•	•			Ioannis Poulakakis					•
Thomas Buchanan		•					Ajay Prasad		•	•	•	
Jenni Buckley		•					Valery Roy			•		•
David Burris		•	•	•	•		Michael Santare			•	•	
Tsu-Wei Chou				•	•		Leonard Schwartz			•		
James Glancey				•			Jonghwan Suhr				•	•
Joshua Hertz			•		•		Herbert Tanner					•
Jill Higginson		•					Erik Thostenson				•	•
Michael Keefe				•			Lian-Ping Wang		•	•	•	
X. Lucas Lu		•					Liyun Wang		•			
Kurt Manal		•					Bingqing Wei			•	•	•



Prof. Ajay Prasad (left) and Joshua Hertz are advancing research aimed at improving fuel cell for automotive and stationary power applications.

Clean energy

Advanced energy solutions

UD mechanical engineering researchers are exploring a variety of advanced energy options derived from renewable resources. With modeling and testing conducted both on campus and as far-reaching as Zurich, Switzerland, their work focuses on fuel cells, supercapacitors and batteries, thermoelectrics and wind energy.

Fuel Cells

Research conducted in the laboratory of **SURESH ADVANI**, George W. Laird Professor and department chair, and **AJAY PRASAD**, Engineering Alumni Distinguished Professor and director of the Center for Fuel Cell Research, focused on polymer electrolyte membrane (PEM) fuel cells.

PEM fuels cells can efficiently convert chemical energy stored in hydrogen fuel to electrical energy with water as the only byproduct, making them good candidates for automotive applications.

The researchers have developed an improved agglomerate model for the PEM

fuel cell's catalyst layer. This important development will increase the overall accuracy of fuel cell computational models, because the catalyst layer is where the fuel cell's electrochemical reactions and significant heat and mass transport occur.

The team also developed novel composite membranes that can operate at higher temperatures and better withstand mechanical and chemical degradation from stresses encountered during fuel cell operation. Fuel cells capable of operating at higher temperatures are desirable due to faster electrode kinetics, improved CO tolerance and simplified water management. Likewise, improving membrane durability

by enhancing its mechanical strength and chemical stability can greatly extend fuel cell life.

Researchers working under Advani and Prasad successfully concluded experiments with a novel solar receiver/reactor to generate hydrogen renewably from sunlight using the Zn/ZnO thermochemical cycle. These experiments were conducted using the high-flux solar simulator at the Paul Scherrer Institute in Zurich.

Professors **MICHAEL SANTARE** and faculty member **ANETTE KARLSSON** are also advancing PEM fuel cell durability. The two are focusing on the mechanical

CONTINUED >>

behavior of electrode materials and the growth of damage in the membrane electrode assembly (MEA).

Using their own experimental-numerical hybrid technique, they extracted electrode properties from experimentally measured properties of Nafion® 211 membranes and MEAs at various temperatures, humidity levels and strain rates (Fig. 1). They are now developing an analytical model to account for membrane fatigue behavior under various loading and environmental conditions.

High-temperature solid oxide fuel cells (SOFC)—good candidates for stationary power applications—are the focus of Assistant Professor **JOSHUA HERTZ'** research. Reducing the SOFC operating temperature from the current 800°C to a more desirable 600°C severely reduces the ionic conductivity of traditional SOFC electrolytes.

Hertz' group discovered that inducing strain at the interface between the electrolyte layer and the underlying substrate improves the ionic conductivity, and that the amount of strain can be increased by reducing the film thickness (Fig. 2). Using magnetron sputtering, Hertz' research team fabricated thin yttria-stabilized zirconia films and found that ionic conductivity at 650°C increased ten-fold when they reduced film thickness from 100 to 6 nm.

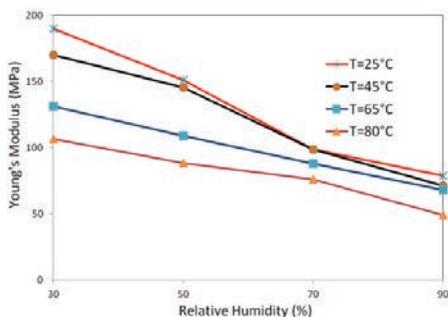


Fig. 1: Calculated Young's modulus of the PEM fuel cell electrode at a strain rate of 0.2/min.

Supercapacitors and Batteries

Professors **TSU-WEI CHOU** and **BINGQING WEI** conducted work on stretchable carbon nanotube (CNT) fiber-based wire-shaped supercapacitors using a prestraining-then-buckling approach. The researchers discovered that at tensile strains from 0-100 percent, or after 20 stretch-release cycles with a maximum strain of 100%, the electrochemical properties were not reduced, but rather, somewhat improved (Fig. 3). Supercapacitors are energy storage devices with very high power densities and cycle life. This research is motivated by the potential integration of wire-shaped supercapacitors with wearable, miniaturized and portable electronic devices.

WEI'S group has continued research on configuring self-assembled CNT macro-films into 2D or 3D (stacking multiple layers) structures with tailored electrical and mechanical properties to develop large-area planar or bulk porous electrodes for energy storage devices including stretchable supercapacitors, pseudocapacitors and Li-ion batteries. Professor Wei was invited to contribute a perspective review in the prestigious journal *Energy and Environmental Science* to discuss his group's CNT macro-films with buckled structures for energy storage applications.

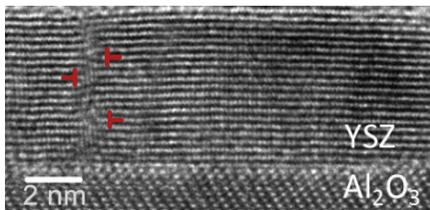


Fig. 2: YSZ thin film over an alumina substrate. Bright spots indicate individual atomic positions in this high resolution transmission electron micrograph. Interfacial strain dilates the atomic layers in the vertical direction and compresses them in the perpendicular directions leading to higher ionic conductivity.

Thermoelectrics

Assistant Professor **JOSEPH FESER**, who joined the department in fall 2013, is designing new materials to exploit microscale heat transfer for extraordinary thermal properties.

Researchers in his laboratory are measuring the thermal properties of materials only nanometers thick and microns wide using pulsed lasers operating on femtosecond time scales. The goal is to increase the efficiency of thermoelectric devices, which convert heat flow directly to electric current using semiconductors. These devices then can be used to generate power, or if run in reverse, as very small refrigerators.

High thermoelectric efficiency requires thermally insulating materials that conduct electricity well. By studying semiconductor materials with embedded nanostructures, Feser hopes to block detrimental random atomic vibrations that carry heat while still allowing electrons to flow freely.

A team pairing ME's **PRASAD** with Materials Science Professor Joshua Zide is working on a novel thermoelectric device that can harvest energy from the environment

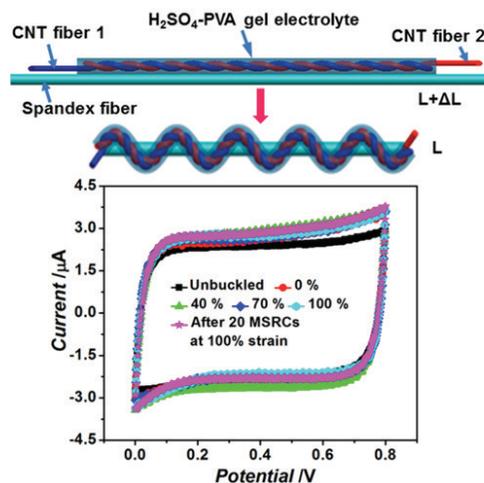


Fig. 3: Fabrication schematic for stretchable wire-shaped supercapacitor (top); cyclic voltammetry curves at different applied strains and after 20 mechanical stretch-release cycles (bottom).

by exploiting temporal fluctuations in the ambient temperature. The device incorporates two heat exchangers of widely differing thermal inertia on either side of a thermoelectric plate. By responding to ambient temperature variations at different rates, it converts environmental temperature fluctuations to a spatial temperature gradient across the thermoelectric plate and generates electricity for low-power applications such as remote sensing and monitoring.

Wind Energy

Large utility-scale wind turbines are promising for renewable energy production, yet they have a reputation for premature drivetrain failure. Despite a 20-year design life, critical gearbox bearings are failing in just five years.

Assistant Professor **DAVID BURRIS** is working to quantify the effects of natural wind-speed variations on 'non-torque' loads and the consequent effects on drivetrain bearing loads. Using blade element theory,

his Materials Tribology group determined that higher wind speeds at the top of the rotor disk for typical wind shear values produced a net pitch moment on the rotor. This, in turn, increases the loads on gearbox bearings and contributes to premature bearing and gearbox failure. His group is currently instrumenting UD's 2MW wind turbine (pictured at right) in an effort to directly correlate the pitch moment to wind shear.

PRASAD is developing guidelines for the optimal spacing of wind turbines in an offshore array. Lateral and longitudinal spacing between individual turbines must be large enough to minimize wake effects from upstream turbines on those located downstream. To determine optimal spacing, Prasad modeled the downstream flow of a single wind turbine as an axisymmetric turbulent wake, and obtained closed-form solutions for the wake diameter, velocity defect and power recovery as a function of downstream distance.



Article by Ajay Prasad

Congressional staffers return to STAR campus for second spin on UD's hydrogen fuel cell bus fleet

Congressional staffers returned to the Science, Technology and Advanced Research (STAR) Campus in February to "kick the tires" of the University of Delaware's hydrogen fuel cell buses. This is the second year in a row that the visitors toured the Center for Fuel Cell Research's bus maintenance facility to learn about UD's research on hydrogen fuel cell/battery hybrid technology. The two-state tour also included stops at W.L. Gore and Associates, Bloom Energy's new manufacturing center on UD's STAR campus, and Air Liquide.

UD's Fuel Cell Bus Program is now in its seventh year of operation. Pictured is UD's 22-foot, 22-seat hydrogen fuel cell bus, the second of its kind on campus. There are only about 20 such fuel cell buses in operation throughout the nation. Two more advanced 40-ft fuel cell buses will be added shortly to complete the fleet.



CBER Update: Incoming director reports industry collaboration key to advancing research opportunities



Michael Santare, professor of mechanical engineering, is the incoming director of the University of Delaware's Center for Biomechanical Engineering Research (CBER).

A 28-year veteran of the department, Santare directed the center's predecessor—the Orthopedic and Biomechanical Engineering Center—from 1993-1998. He was also a founding faculty member of the university's Biomechanics and Movement Science Program.

CBER is an interdisciplinary center that combines engineering science and clinical technology to reduce the impact of disease on individuals in their everyday lives. A joint effort among the departments of mechanical engineering, physical therapy, biological sciences and kinesiology and applied physiology, research topics range from modeling the neural control of limb movements, to engineering of medical and surgical devices, to the use of functional electrical stimulation and robots in rehabilitation following stroke, to the understanding, prevention and treatment of osteoarthritis. CBER research is supported by the National Institutes of Health and other funding sources.

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

We recently sat down with Prof. Santare to discuss his vision for leading CBER forward.

MEEG: What is your vision for CBER?

SANTARE: CBER developed in mechanical engineering in the 1990s as a way for biomechanics researchers within and outside the College of Engineering to build collaborations and visibility. Since 1998, the center has flourished under the leadership of its former directors Tom Buchanan, Kurt Manal and Jill Higginson. The center's funding model of supporting programs through overhead return from research grants, however, has been challenging to sustain.

My vision is to develop a new model that involves increased industry collaboration. Short-term, I plan to assemble an advisory board comprised of industry

representatives who can help identify areas where collaboration between CBER and industry can broaden our long-term impact. Key companies for the board are those developing assistive and surgical technologies, producing orthopedic implant and medical devices, or those researching such areas as motor control, musculoskeletal diseases and tissues engineering.

MEEG: How does CBER promote and support undergraduate research?

SANTARE: Last summer, CBER piloted a summer program that supported nine students in biomechanics labs across campus (see page 16), with supplemental funding from UD's Undergraduate Research Program and the mechanical engineering department. This year, we hope to secure National Science Foundation funding for future summer Research Experiences for Undergraduates to expand the program.

MEEG: How will the University's new Science, Technology and Research (STAR) campus enhance CBER activities?

SANTARE: The STAR campus, which opened in January 2014, provides state-of-the-art laboratory space for a number of CBER faculty. It also houses the Delaware Rehabilitation Institute, the Department of Physical Therapy and other components of the College of Health Science, with plans to provide space for biomedical and biotechnology companies and community clinics. Collaborations between CBER researchers and clinicians will leverage their collective strengths to better address the needs of patients in the surrounding region and accelerate the innovation pipeline, shortening the time from discovery to delivery. The CBER home office remains in Spencer Laboratory on the main UD campus.



MEEG: What can CBER offer the UD community, industry, and local colleges?

SANTARE: CBER fosters collaboration among students and faculty experts from all areas of biomechanics, including materials characterization, musculoskeletal modeling, device design, gait analysis, in vitro and in vivo studies. State-of-the-art labs are located across campus, including brand new facilities for testing human subjects on the STAR campus. We welcome interdisciplinary partnerships with our campus, industry or academic peers and the opportunity to develop mutually beneficial initiatives.

MEEG: How can mechanical engineering alumni and friends get involved?

SANTARE: Observe data collection, participate in demonstrations, sponsor student awards or projects, share your experiences with current undergraduate students and propose cutting edge studies.

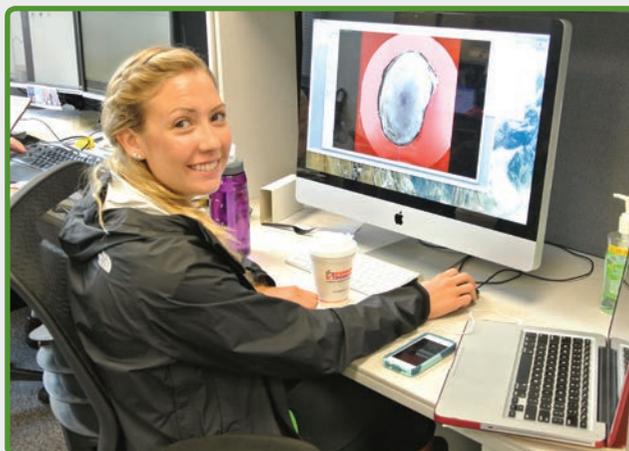
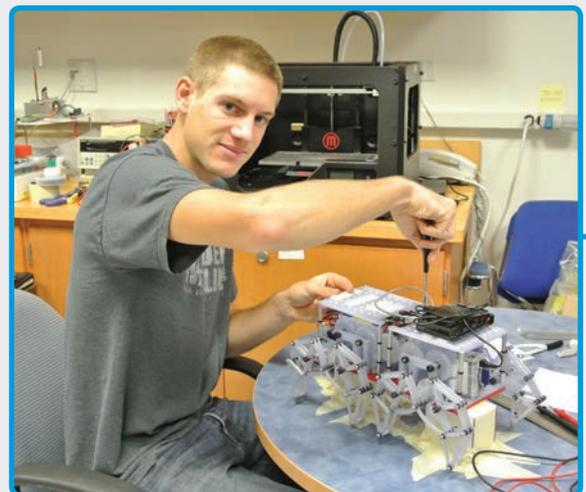
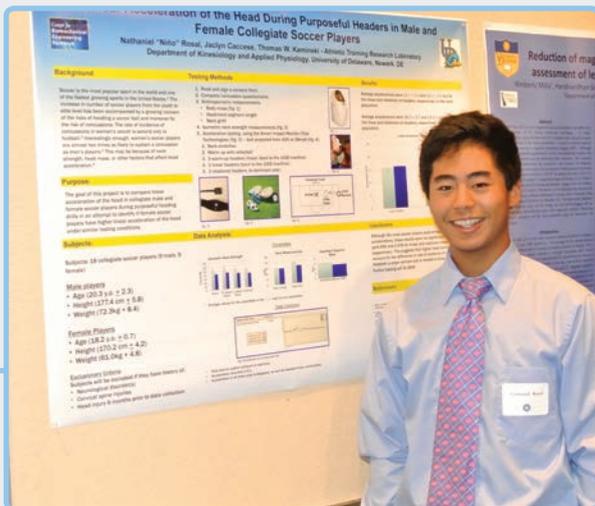
Another great opportunity to see what's happening at CBER is to attend the 11th Annual CBER Research Symposium Monday, April 21, 2014 on the UD campus, where students will present biomechanics research projects in poster and podium sessions.

Alberto Esquenazi, M.D., John Otto Haas Chair and Professor, Department of Physical Medicine & Rehabilitation & chief medical officer and director of the Gait & Motion Analysis Laboratory and Regional Amputee Center at MossRehab of the Einstein Healthcare Network, will deliver the keynote address. More information is available at www.cber.udel.edu.

I encourage you to email me at santare@udel.edu, call me at 302-831-3466, or plan a visit to the CBER office in Spencer Lab while you're on campus.

Undergraduate Research

Nine undergraduate biomechanics students presented their work at the Undergraduate Research Celebratory Symposium following 10 weeks of immersive group-based training and research last summer. The experience was organized by Profs. Lucas Lu and Jill Higginson, in partnership with the mechanical engineering department. Participating students and their projects included:



KELSEY DEVLIN performed quantitative characterization of the material properties of Mandibular Condylar Cartilage (MCC) top and bottom zones. MCC is a temporomandibular joint disorder (TJD). TJD's affect 20-25% of the population and involve joint cartilage degeneration.

Faculty advisor: X. Lucas Lu, mechanical engineering

CLAIRE BUTKERAIT investigated changes in body weight and self-selected walking speed before and after a locomotor intervention, comparing factors such as age, time since stroke, seasonal change and initial body mass index (BMI) that affect weight changes in post-stroke individuals.

Faculty advisor: Stuart Binder-Macleod, exercise science

ALEXANDER REVELL designed and assembled a legged platform to support various configurations of sensors for use in surveillance, reconnaissance, and search-and-rescue.

Faculty advisor: Ioannis Poulakakis, mechanical engineering

XIAOYU (DAVE) GU explored whether mechanical loading from physical exercise will help improve bone properties for the 25.8 million Americans—a staggering 8.3 percent of the U.S. population—suffering from diabetes.

Faculty advisor: Liyun Wang, mechanical engineering

KEVIN LAPHAM compared two pre-operative physical therapy treatments (strength and perturbation training), and their effect on patient perceived knee function and gait biomechanics after ACL injury.

Faculty advisor: Lynn Snyder-Mackler, exercise science

JESSICA PENMAN quantified the mechanics of knee distraction in a clinical setting by studying distraction distance, distraction force and number of discrete distraction intervals.

Faculty advisor: Jenni Buckley, mechanical engineering

NATHANIEL (NIÑO) ROSAL compared linear acceleration of the head in collegiate male and female soccer players during purposeful heading drills in an attempt to identify if female soccer players have higher linear acceleration of the head under similar testing conditions.

Faculty advisor: Thomas Kaminski, exercise science- exercise physiology

MOLLY WESSEL developed and validated a biomechanical testing protocol simulating the single leg stance (SLS) of the gait cycle.

Faculty advisor: Jenni Buckley, biomedical engineering

JESSICA LEWIS analyzed 2-D strain on intact L3-L4 intervertebral discs focusing on three regions of the annulus fibrosus including the right lateral, posterior, and anterior, to help decrease disc degeneration which leads to low back pain.

Faculty advisor: Dawn Elliott, biomedical engineering



Robotics

Prof. Herbert Tanner (right) and Ioannis Poulakakis (center) are collaborating on a robotics system to detect radio active materials using basic Geiger counters mounted on small rovers or quadrotor helicopters.

Remote network radiation sensing

Just as networks of distributed sensors help trigger timely responses to natural disasters such as hurricanes, earthquakes and tsunamis, a team of mechanical engineers is devising a networked detection system to effectively respond to the real and present risk of nuclear or radiological attack.

Herbert G. Tanner, associate professor, and Ioannis Poulakakis, assistant professor, are collaborating on a robotics system to detect radioactive material using basic Geiger counters mounted on small rovers or quadrotor helicopters. Tanner, the lead investigator, said this simple, existing technology equipped with sophisticated sensors and algorithms could enable visual tracking of a moving target, including the ability to concretely decide whether the source is friend or foe.

Small or shielded quantities of nuclear material are difficult to detect at a distance since their sensory signature is disguised in naturally occurring background radiation—in other words, buried in noise.

The UD researchers' approach involves using analytical decision-making to determine exactly how the relative motion between sensors and source affects the probability of making a detection error. Rather than simply interrogating data, they are searching for

equations that link motion to decision-making performance.

“Such equations can be treasure for engineers,” said Poulakakis. “Not only can they help reveal the optimal motion of sensors, they can also indicate the right design specifications, both for the sensors and the platforms that drive them.”

The team’s work supports recommendations from national security researchers from Los Alamos and Sandia National labs that multiple layers of prevention are needed to mitigate the impact of a nuclear or radioactive incident. The labs explicitly recommend networks of detectors deployed along U.S. roads and highways to help locate illicit material that either slips through border checks, or is present in quantities too small to trigger portal alarms.

Uncharted territory

Amazingly, radiation detection and nuclear nonproliferation problems receive little attention outside national laboratories. Only a handful of researchers, including this UD team, focus on distributed decision-making problems, and fewer work on the theoretical aspects of the networked radiation detection problem.

Tanner and Poulakakis believe that prevention is key, and that researchers like themselves can affect future outcomes now by combining existing technology and new algorithms, rather than waiting until new miracle sensors are invented.

“The more sophisticated and efficient our defenses are,” said Tanner, “the more elaborate our attackers need to be, which, in turn, makes them easier for us to detect.”

Analytical decision making

Similar problems of distinguishing signal from noise can be found in a variety of other domains, from optical communications and sonar-based surveillance—where underlying physical processes even share similar statistics—to radar-based detection, bacterial sensing, and even in experimental energy physics. In all of these scenarios, figuring out how the mechanics of measurement interplay with detection error probabilities is crucial to making timely and confident decisions.

Collaborating with researchers from Los Alamos National Lab, Tanner and Poulakakis are now seeking federal support for their work to develop first prototype proof-of-concept systems. Other UD collaborators on the project include Chetan Pahlajani, assistant professor of mathematical sciences, and doctoral student Jianxin Sun.





Composites and Nanotechnology

Atoms to Applications

Recent research in materials engineering has targeted the development of multifunctional materials with adaptive, sensory and energy storage capabilities. At UD, researchers are studying fundamental material behavior at the micro- and nano-scales that will have future applications ranging from fuel cells to ultra-lightweight structural materials.

Solid State Electrolytes for Clean Energy

Polycrystalline solid electrolytes, materials that show exceptionally high values of ionic conductivity, have wide applications in batteries, sensors and solid oxide fuel cells. Professor **JOSHUA HERTZ**, with graduate student Ben McNealy, has shown that the grain boundaries strongly affect the bulk material properties.

Although only about one nanometer thick, the heterogeneous grain boundaries block ion conduction and it is crucial to understand their properties. Using a two-dimensional numerical simulation, the researchers studied the influence of heterogeneous grain boundary properties on the electrical impedance. Their research confirms that the grain boundary properties in most solid electrolyte samples are

heterogeneous and sheds light on how the measured electrical response depends on the property distributions.

The researchers recently published their results in the journal *Solid State Ionics* and received the Best Poster Award at the 19th International Conference in Solid State Ionics this summer in Kyoto.

Textile-Based Flexible Supercapacitors

Professors **TSU-WEI CHOU** and **BINGQING WEI** studied stretchable carbon nanotube fiber-based supercapacitors. Motivated by their potential use in wearable energy devices, the researchers utilized a novel approach to produce the stretchable supercapacitor by using a Spandex fiber as

the substrate, carbon nanotube fibers as the active electrodes and polyvinyl alcohol sulfuric acid gel as the solid electrolyte. The Spandex is pre-strained before bonding with the nanotube fiber based supercapacitor. After relaxing the spandex, the nanotube fiber supercapacitor buckles into a sinusoidal shape.

The research team demonstrated that the capacitor could be stretched repeatedly to strains of 100 percent without any degradation in electrical performance, indicating excellent electrochemical stability. In fact, the specific capacitance of the flexible supercapacitor increased by 8 percent after stretching. Professors Chou and Wei published their findings in *Advanced Energy Materials*. The first author on the paper was Ping Xu, a visiting student from Donghua University in Shanghai, China.

Molecular Modeling of Nanotube Bundles

The novel mechanical, electrical and thermal properties of carbon nanotubes has stimulated interest in using these materials as structural and functional reinforcement in composite materials. Professors **JACK GILLESPIE** and **BAZLE HAQUE** are investigating the properties of nanotube bundles where axially aligned nanotubes are packed together creating a yarn. Understanding the nanoscale mechanical behavior and failure mechanisms will lay the groundwork for future multifunctional high-performance composites.

The research team studied the mechanical response of nanotube bundles under tensile, compressive and torsional loadings using molecular dynamics simulations. Simulation results revealed that the stiffness and load carrying capacity increases with bundle diameter for the three modes of loading. While nanotube-nanotube van der Waals interactions do not have a significant effect on tensile behavior, these interactions combined with lateral boundary conditions alter the compressive behavior by changing the buckling mode shape.

Multi-Scale Modeling of the Fiber-Matrix

Continuing their molecular modeling efforts, **GILLESPIE** and **HAQUE** are also studying the fiber-matrix interface/interphase in advanced composites. The interface in composites is not just a boundary, but rather a complex nanoscale region near the fiber surface with graded material properties (interphase). This area between the fibers and polymer matrix in advanced composites is of fundamental importance since that is the region of stress transfer and affects the overall composite performance.

The research team is using molecular dynamics modeling to examine the formation of the interphase during composite processing and also to develop mixed-mode traction laws based on bond breakage. This predictive capability will enable researchers to design the chemistry of the fiber surface for maximum strength and energy absorption. The molecular dynamics models provide the input for modeling at higher length scales.

Transitioning Basic Research to Applications

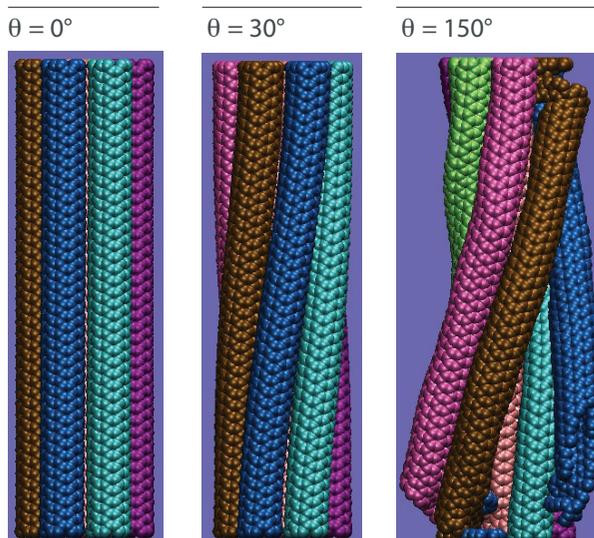
Collaborative partnerships enable the rapid transition of basic research and discovery in the laboratory to future applications. In cross-disciplinary research, Professors **GILLESPIE** and **SHRIDHAR YARLAGADDA** (CCM, Electrical Engineering) received a

\$3-million DARPA grant to develop rapid prototyping techniques to manufacture ankle-foot orthoses for injured soldiers.

Advanced, lightweight composites offer advantages over conventional materials, which are too thick and heavy to meet design requirements, including the ability to tailor stiffness to an individual patient's needs while remaining thin enough to be worn with a shoe. Gillespie and Yarlagadda are further collaborating with **STEVEN STANHOPE** (BADER Consortium, Kinesiology & Applied Physiology). This unique collaboration between researchers in composite materials along with health sciences builds on expertise in manufacturing and design of composites combined with the ability to implement the orthoses in clinical trials.

ILC Dover, a company that has sponsored several mechanical engineering senior design projects, is leading a team that received a \$4.4 million NASA contract to develop the next-generation spacesuit which will operate at higher levels of pressure and have a number of rigid composite components. Bazle Haque and Jack Gillespie are leading efforts to design a material that can meet all of the design requirements.

Article by Erik Thostenson



Molecular dynamics simulation results showing the torsional deformation and damage modes of a carbon nanotube bundle at varying angles of twist.



Joshua Hertz

Assistant Professor of Mechanical Engineering

The Center for Fuel Cell Research is part of the University of Delaware's commitment to be a leading resource for innovative energy technologies. Current research in the center focuses on three types of fuel cells—polymer electrolyte membrane fuel cells, direct methanol fuel cells and solid oxide fuel cells.

As a ceramic engineer, Joshua Hertz has found his niche in solid oxide fuel cells, which work by electrochemically oxidizing a fuel at high temperature thereby transforming chemical energy directly into electricity. This type of fuel cell is best suited for stationary power applications.

Hertz, who is an assistant professor of mechanical engineering, explains that polymer-based fuel cells use a membrane that conducts *hydrogen* ions, likely requiring an infrastructure that generates and stores hydrogen for implementation.

"If we can develop ceramic materials that conduct *oxygen* ions, then we can put at the anode anything that is able to consume the oxygen, including gasoline, natural gas, biofuels, and diesel," he says. "And the infrastructure for all of these options already exists." One challenge is that ceramics have high-bond strength,

so it is difficult for ions to move through these solid materials. In addition, for fuel cell applications, the ceramic membrane has to be able to conduct only oxygen ions and not electrons because electrons short circuit the fuel cell.

"Right now," Hertz says, "we have materials that work well except that they require high operating temperatures – nearly 1,000 °C – and we need materials that will have the same properties at temperatures around 500 °C. If we can achieve that, we can change the energy landscape of the country."

In one project, supported by the Department of Energy, Hertz is investigating ways to control material composition at the single nanometer level and use that to improve low-temperature oxygen ion conductivity.

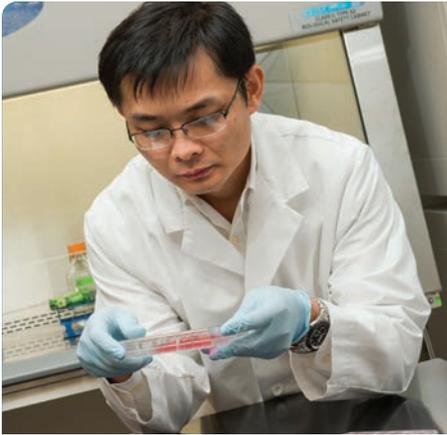
"There are two classic materials, zirconium oxide and cerium oxide, that have the same crystal structure, but different atom sizes," he explains. "If we put them together, they need to stretch to accommodate the size difference, and we've found that stretching has a big impact on how easily the oxygen ions move through."

Hertz is also developing computer models to describe oxygen ion motion through materials. He won a best poster award for this work at the 19th International Conference on Solid State Ionics in Japan in June 2013.

The conference, held once every two years, provides scientists and engineers from around the globe a forum to exchange ideas, discuss fundamentals, and collaborate in the field of ion transportation in solids. Hertz's poster, "Impedance of Polycrystals with Normally Distributed Grain Boundary Conductivities," focused on elucidating the effects of a material having a range of ion conductivity values across different parts of the specimen. Understanding this behavior is important to the future of engineering better fuel cells, batteries, and chemical sensors.

"Solid oxide fuel cell technology is at a nice place now for research that can be done at UD because while there are still key hurdles, we're close," Hertz says. "There's nothing fundamental standing between this device concept, which has been around since the 1930s, and commercial breakthrough. We're on the verge."

Article by Diane Kukich



X. Lucas Lu

Assistant Professor of Mechanical Engineering

A robotic hand that can hold a glass of water helped shape X. Lucas Lu's career path.

"When I was an undergraduate at Tsinghua University, our department had a group working in rehabilitation devices," he says. "I was amazed that basic mechanical engineering technologies could have such an impact on quality of life."

As a graduate student working in the orthopedic department at Columbia University, Lu was exposed to the clinical side of engineering. "I worked closely with surgeons as they obtained samples from human tissues," he says. "It was fascinating to observe them dissecting."

Now an assistant professor in the UD Department of Mechanical Engineering, Lu has dedicated himself to 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 soldiers and athletes, many of whom are young. Lu recently received a \$1.1 million research grant from the Department of Defense to study the effectiveness of zoledronic acid (ZA) in the treatment and prevention of PTOA.

"ZA is an FDA approved drug to prevent skeletal fractures in cancer patients and to treat osteoporosis," Lu says. "But its use in younger patients could hamper the natural development of bones." He is also investigating whether localized injection of ZA can prevent OA from developing without compromising the natural bone remodeling process. His team includes Christopher Price and Liyun Wang from mechanical engineering, and Randall Duncan from biology.

A second area of interest for Lu is rehabilitation for microfracture surgery to repair cartilage lesions. Cartilage enables smooth motion at joints, so when it breaks down or is lost due to OA or injury, joint mobility decreases and movement becomes painful. Young athletes suffering from trauma-induced cartilage loss are often treated with microfracture surgery, a minimally invasive procedure that creates tiny pictures in the bone to stimulate bone marrow growth in the damaged area. Stem cells in the bone marrow then generate new articular cartilage.

Funded by pilot grants from NASA, NIH and the Musculoskeletal Transplant Foundation, Lu is working with Lynn Snyder-Mackler in the Department of

Physical Therapy, and Dr. Michael Axe, a well-known orthopedic surgeon, to determine whether weight bearing during post-surgical rehabilitation will enhance the deposition and quality of newly repaired tissue at the injury site.

Lu is also collaborating with David Burris, assistant professor of mechanical engineering, and orthodontists at Children's Hospital of Philadelphia, to investigate the use of lubricants to treat temporomandibular joint (TMJ) disorders, which cause pain and tenderness in the face, jaw and neck for some 10 million Americans. Burris is an expert in tribology—the science and technology of such phenomena as friction, wear and lubrication—and the research team is searching for a new therapeutic technique for the treatment of TMD.

"All of these projects use engineering to solve biomedical problems," Lu says. "In a way, engineers, biologists, physical therapists, and clinicians speak different languages, but it's essential for us to work together if we hope to achieve the best possible human health outcomes."

Article by Diane Kukich

Senior Design

Students tackle real-world engineering challenges

Senior Design is a six-credit capstone design course designed to provide young engineers experience in solving real world engineering programs while working on a design team. Teams select a project, discover customers' wants, benchmark the best practices for each desired function, generate design concepts and select the best concept. Students then build a prototype, test it and improve their designs. Faculty provide guidance on the design process, while sponsors provide project direction and mentoring throughout, including hosting student teams at company facilities to expose them to the work environment.



Is your company interested in building relationships with some of the brightest young minds in the industry? Contact [NATE CLOUD](#) about Senior Design Sponsorship opportunities at CLOUDN@UDEL.EDU.

Meet the teams



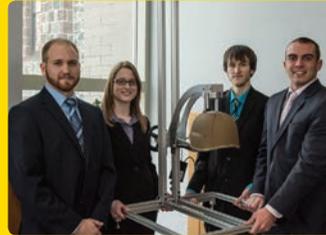
TEAM ALCORE: ALUMINUM HONEYCOMB BLOCK LOADER

Brian Bird, Michael Garbarino, Mark Jenkins, Jesenia Velez



TEAM ASHLAND: PAINT APPLICATION "FEEL" SYSTEM

Christopher Langston, Clayton Merkle, Nathan Giguere, Matthew Lano



TEAM CHESAPEAKE TESTING: HELMET COMPRESSION FIXTURE

Tristan Assimos, Katherine Bagwell, Frederick Wilkinson, Michael Meck



TEAM CNH AMERICA: TRACTOR LINKAGE TOOL CARRIER

Christopher Hewitt, Christopher Beadle, Douglas Stewart, Jamieson Weiss



TEAM DEPUY SYNTHES: ORTHOPEDIC PART DRYER IMPROVEMENT

Lauren Kewley, Adam Simays, Jessica Corson, Brian Lazzaro



TEAM DOW ELECTRONIC MATERIALS: LARGE MATERIAL TOTE PROCESS ADAPTION

Rachael Lutchmedial, Alexander Statchnik, Jessica Harrington, Anthony Vacaro, Nicholas Bishop



TEAM ESCO: SEAM SEAL APPLICATOR

Devin Appel, Victoria Denning, Benjamin Minich, Kevin Eckenhoff, Luxiao Zhang



TEAM FARO: SHOCK TEST FIXTURE

Matthew Howard, Brandon Zimmerman, Micah Uzuh, Connor O'Leary



TEAM GE AVIATION: LIFT DEVICE AND SAFETY SHROUD

Alex Lagrotta, Samuel Kurkoski, Scott Chubb, Pedram Barakhshan



TEAM GGB-NORTH AMERICA: DYNAMIC WEAR TEST SYSTEM

Andrew Caulfield, Jason Hernandez, Michael Pignataro, Thomas Soper, Qiheng Ding



TEAM SCHILLER GROUNDS CARE: BI-DIRECTIONAL WALK-BEHIND BLOWER

Phillip Mirabella, Alexander Mundell, Brian Hwang, Lu Xu



TEAM SIEMANS HEALTHCARE DIAGNOSTICS: FILM CANISTER TENSION TESTER

Nebiyou Getinet, John Ford, John Highberger, Peter Hauser



TEAM SOUTHCO: MTS LOAD FRAME SYSTEM RE-DESIGN

Yehan Zhang, Yingshuo Fu, Frederick Mauer, Geoffrey Lukin, Benjamin Natrin



TEAM SUPERIOR TUBE: VAPOR DEGREASER BASKET DESIGN

Mingze Niu, Kenneth Manley, Nicolette Grannum, Stanley Anderson



TEAM SURVIVE: AUTONOMOUS TIDE MEASUREMENT STATION

Davis Flanagan, Emily Pierce, Daniel Kleinstuber, Tengyuan Hao, Austin Bragg



TEAM W.L. GORE: LIQUID FLOW TEST STAND

Wen Li, Joshua Matz, Alec Ploshnick, Richard Stanton



TEAM WEST PHARMACEUTICAL: ELASTOMER MATERIAL PROPERTY INLINE TESTER

Kan Liu, Alexander Dulin, Nikolas Schreiber, Michael Cooke



FSAE TEAM

Harmon Amakobe, David Anlian, Douglas Corley, Alan Radojic, Joshua Akell, David Zipf, Sharnita James Seated: Stephen Rosenkrantz, Kneeling: Justin Greenidge



TEAM NATIONAL INSTRUMENTS: MYHEART

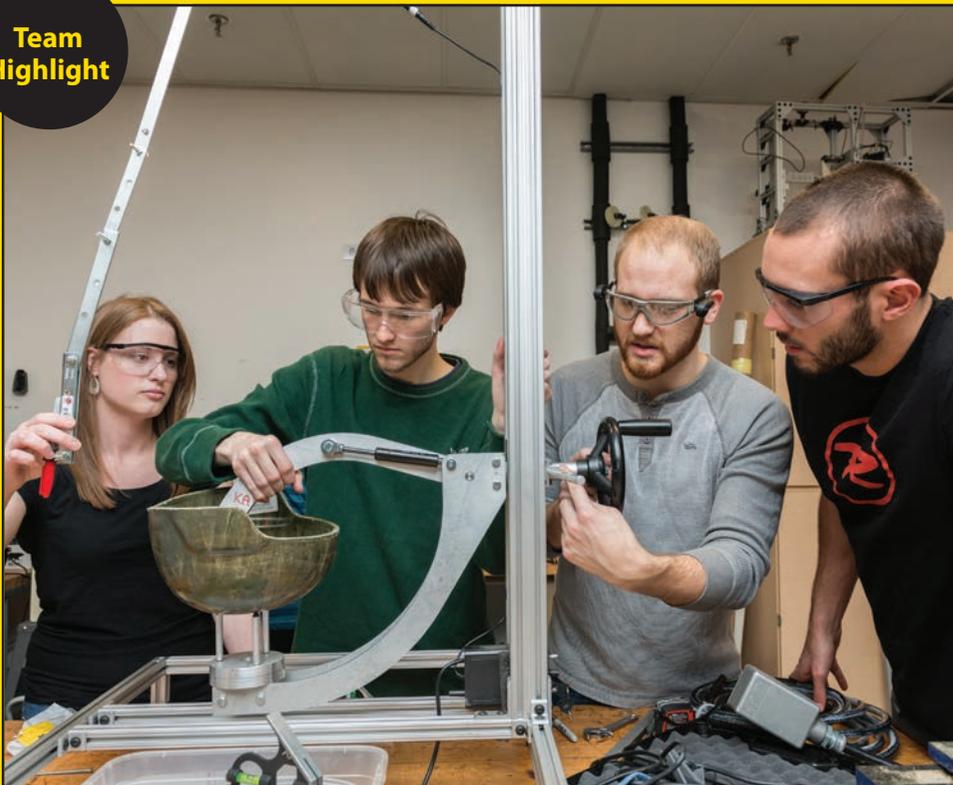
Rossiny Beaucejour, Daniel Clark, Mark Elrod, Zachary Fox, James Manning, Chris Quezon, Hayley Williams



TEAM NATIONAL INSTRUMENTS: SPIROMETER

Timothy Baran, Ian Beringer, Stacy Hand, Ling Li, Tonghua Li, Christopher May

Team Highlight



Team Chesapeake Testing

Chesapeake Testing, which provides ballistic experimentation to assess personal protective equipment, sponsored a senior design team to create a system to standardize two ballistic tests conducted on military helmets.

The students were tasked with creating a device that accelerates and simplifies the marking of two types of helmets for the different tests. The team successfully developed a laser-guided clamping system to secure helmets of varying sizes during testing and a marker attachment to mark helmets for ballistic testing. Chesapeake Testing plans to use the team's design.

Team Highlight



Team Dow Electronic Materials

Dow Electronic Materials sponsored a senior design team to create an apparatus to mix and extract large quantities of raw materials from industrial totes and barrels. The team's design will allow operators of all sizes to successfully complete their work with Dow's new, larger industrial totes. The team created a mobile work station, complete with steps for smaller operators, and a crane system that allows for easy mixing and extracting. Dow is currently testing the new design and taking some of the student design ideas into consideration.



TEAM ROPEIT: ROPEIT PRO
Melanie Davis, Marissa Eppes, Zachary Firth, Christopher Hazel, Andrew Singles, Christine Wilkerson



TEAM UD HEALTHCARE THEATRE: VIDALVEST-WEARABLE CHEST COMPRESSION SIMULATOR
Samantha Greeley, Benjamin Henry, Paul Ojewoye, Lindsay Scheetz, Bryce Sheppard



TEAM UD HEALTHCARE THEATRE: TRACHEOSTOMY CARE OVERLAY SYSTEM
Joseph Biggs, Devon Bond, Dominic Campagnola, Edward Doll, Nathan Hott



TEAM W.L. GORE: PERISTALTIC TEST SYSTEM FOR GI STENT
Christopher Fischer, Caleb Frost, Alexander Revell, Benjamin White



TEAM QUADCREW: ADAPTIVE ROWING SYSTEM
Robert Bryant, Matthew Imm, Sarah Masters, Molly Wessel



TEAM INDEPENDENCE PROSTHETICS & ORTHOTICS: SYSTEM FOR AMPUTEES
Connor Bortz, Matthew Galbraith, Jessica Lewis, Chelsea Madden, Anthony Rossi



TEAM LIFECELL: FAT REMOVAL TOOL FOR HUMAN TISSUE
Brandon Boles, Audrey Guyer, Ryan Mitchell, Krunal Parikh, Matthew Ringer



TEAM UD PHYSICAL THERAPY INFANT MOBILITY LAB: GARMENT BASED EXOSKELETON
Kevin Chang, John Koshy, Robert Oblender, Michael Olaya



TEAM STOCKLEY CENTER: ADULT CHANGING TABLE

James Carlucci, John Darden, Ryan Firman, Saman Rostami, Anna Sung



TEAM UD BME BIOMECHANICS LAB: MECHANICAL ACTUATOR FOR MAGNETIC RESONANCE ELASTOGRAPHY

Christian Aurup, Caitlin Banks, Brittany King, Kenneth Warren



TEAM UD DEPARTMENT OF BIOLOGY: MODEL OF BREAST CANCER BONE METASTASIS

Keagan Collins, Laura Graefe, Christopher Hubley, Jaymin Modi, Bethany Porter, Ian Roberts



TEAM WEST PHARMACEUTICALS: INJECTABLE DRUG DELIVERY SYSTEM

Madison Defrank, Derek Hunter, Kailey Nelson, Ryan O'Boyle, Hayley Shaw

Team Highlight



Team QuadCrew

Yes U Can, a Newark based nonprofit organization, sponsored Team QuadCrew to redesign mechanisms used in a crew boats for disabled rowers. The team's assignment was to develop and commercialize new adaptive technology that is inclusive for individuals with physical disabilities, including quadriplegia, paraplegia and multiple sclerosis. The students' design featured five sub-components, including an adaptive seat, a leg motion system, a safety system, a propulsion system and a plan for boat accessibility. The team completed initial testing in December 2013 and plans to test the device with a disabled rower this spring. They are working to patent their design and hopes to make their technology commercially available.

Highlights, News, Awards



Undergrad's chance encounter with Nelson Mandela

Not everyone gets the chance to meet a world leader, but for senior Rachael Lutchmedial, her encounter at a young age with Nelson Mandela is a memory she'll never forget.

Growing up in the Republic of Trinidad and Tobago, Lutchmedial said she heard numerous stories about the anti-apartheid revolutionary, which inspired her to learn more about the man many in her country consider a freedom fighter.

At the age of 12, she got the chance to meet the leader when her family was invited to an event held in Mandela's honor at the Centre of Excellence in Macoya, Trinidad.

Lutchmedial and her sisters walked up to Mandela's table to ask for an autograph and were initially turned away by security before Mandela asked that they be brought back. As he signed her program, Lutchmedial said she told Mandela of the school project she completed about him.

"He went out of his way to let us meet him and I'm really in awe of his actions that night," she said. "The experience gave me courage and taught me the importance of having humility, even as a great, renowned leader."

Over the years, Lutchmedial followed Mandela's life and was saddened to hear of his death in December. His legacy, she said, is the belief that people of all races should live harmoniously and the importance of fighting against injustice.

"Nelson Mandela encouraged people to stand up for what they believe is right, not just for themselves but for everyone else as well," Lutchmedial said. "One person can make a difference if they truly believe in the cause they are fighting for."

Following his example, Lutchmedial plans to return to Trinidad after graduation to use her mechanical engineering knowledge and minors in electrical engineering and sustainable energy technology to find a job in the sustainable energy field.

Article by Collette L. O'Neal



Crouse wins Horn Program video pitch competition

Mechanical engineering major Austin Crouse's video for Rapid Print, a 3D part and component printing business, earned the top prize of \$1,000 in the Horn Program in Entrepreneurship's first video pitch competition, "Perfect Pitch."

The competition called for students to think of an original business idea and create a video that best described that concept to its target audience of investors, potential partners or future customers. Effectiveness of the "Perfect Pitch" hinged on the product or service's perceived value, the creator's vision and the tone of the pitch.

Crouse's video (available on the Horn program's Facebook page) outshined the competition in three voting categories: "likes" on the Horn Program's Facebook page, panel judge scores and audience favorites.

"The Horn Program has played such a key role in developing all of my ideas and I am very fortunate to have access to such a huge community of entrepreneurs I couldn't find anywhere else," said Crouse. "This prize money will allow me to further develop my 3D printing service by allowing me to purchase another 3D printer and a filament extruder to recycle plastic for printing."

QuadCrew members invited to Clinton Global Initiative

Four up-and-coming Blue Hen engineers will represent UD at the 2014 Clinton Global Initiative University (CGI U) in Phoenix this spring to showcase their adaptive rowing prototype that allows those with quadriplegia, paraplegia, hemiplegia, multiple sclerosis and paresis to operate a crew boat.

“Current adaptive rowing equipment caters to a narrow audience because it relies on the user having significant upper body strength,” said UD senior Sarah Masters, team leader for senior design team QuadCrew. “We’ve developed new technology that is inclusive of individuals with a wider range of physical disabilities.”

Masters and teammates Robert Bryant (MEEG 2014), Matthew Imm and Molly Wessel, both biomedical engineering majors, planned, designed and developed the adaptive technology as part of their capstone senior design course last fall under the advisement of Jenni Buckley, assistant professor (see Senior Design, page 30).

The prototype features a propulsion system, an adaptive seat and a leg motion seat synchronizing system – all designed to fit



Pictured left to right: Robert Bryant (ME), Sarah Masters (ME), Molly Wessel (BME), Matthew Imm (BME)

in the shell of a standard crew boat. The team tested its design on the Wilmington Riverfront this winter with help from the UD women’s rowing team.

Clinton Global Initiative University

Founded by former President Bill Clinton in 2007, CGI U brings together the next generation of global leaders from 30 universities and colleges to solve challenges in education, environment and climate

change, peace and human rights, poverty alleviation and public health.

“We hope that working with others at CGI U and attending these learning sessions will help us create an action plan for commercializing our device,” Masters said. The team is already working with UD’s Office of Economic Innovation and Partnerships to patent their design and and pursuing a licensing deal with a major rowing company.

Article by Collette L. O’Neal



NSF graduate research fellowship

Benjamin Hockman (ME Honors ‘13) was among nine University of Delaware students and alumni selected for the prestigious National Science Foundation’s Graduate Research Fellowship Program in 2013. The highly competitive program supports outstanding graduate students in science, technology, engineering and mathematics disciplines who are pursuing research-based master’s and doctoral degrees at accredited U.S. institutions. Fellows receive

a three-year annual stipend of \$30,000 along with a \$12,000 cost-of-education allowance for tuition and fees, opportunities for international research and professional development, and the freedom to conduct their own research at any accredited U.S. institution of graduate education they choose. Hockman is pursuing his research at Stanford University.

Adapted from an article by Tracey Bryant

Engineers helping amputees

Students gain hands-on fabrication experience in multi-faced internships

Mechanical engineering students gained hands-on fabrication experience last summer as interns with Independence Prosthetics Orthotics, a full service orthotic and prosthetic care and diabetic foot management company based in Newark, Del.

The students shadowed clinicians during patient appointments and fittings and learned about administrative back-end processes involving health care and insurance.

“As a mechanical engineering major with a minor in biomedical engineering and math, I was interested in exploring prosthetics because the field involves both a mechanical and biomedical component,” said Lindsay Evans, then a senior.

John Horne, the company’s president, explained that as prosthetics technology incorporates an increasing number of bionic devices that use batteries, electrodes and computer circuits, opportunities abound for engineers to become involved in the industry. Because Independence has its own manufacturing facility, clinicians and technicians often see a patient in the morning, fabricate a prosthetic device and have it ready the same day – an advantage for students eager to learn.

Junior Zachary Presant said shadowing clinicians demonstrated the engineering principles he has learned in class. When patients come to Independence with pain, discomfort or pressure in their orthotic or prosthetic, the technicians consider the concepts of force and pressure when modifying the device for greater comfort, an engineering application he had never considered.



Students working as interns with a local prosthetics-orthotics company are applying their knowledge to help amputees.

Presant’s favorite part was the process of fitting, manufacturing and laminating a leg socket in the laboratory because it was hands-on and allowed him to work with some of the machines to assist the technicians.

“I spent quite a bit of time observing, because some of the processes must be handled with such care,” he said. “But I enjoyed being able to apply my engineering knowledge, especially during appointments with orthotists.”

The internship program grew out of the company’s sponsorship of a mechanical engineering sophomore design competition last spring, where Horne challenged the students to develop innovative prosthetics

to help amputees remain active. The result was dozens of ideas, including a quick-change prosthetic leg for triathletes and a prosthetic designed for walking on sand (see story on following page).

“It was pretty remarkable and exciting to see the creativity the engineering students displayed in their prosthetic designs,” said Horne, who showcased several of the students’ promising designs at a national conference.



Design showcase

Undergraduates showcased new inventions during a first of its kind juried research design presentation on campus last May.

Design innovations ranged from quick-change prosthetic legs for triathletes to assistive rowing devices, all developed by students in collaboration with industry sponsors Yes U Can Foundation and Independence Prosthetics – Orthotics, and in cooperation with UD men’s and women’s crew teams.

“This is one way we train our students to handle engineering problems in the real world. This event provides students a forum to practice presenting their research and field any questions a professional or professor might have,” explained Jenni Buckley, assistant professor of mechanical engineering, who organized the event.

John Horne, president and founder of Independence Prosthetics – Orthotics, sponsored the sophomore prosthesis design portion of the event. Horne spoke to the students at the beginning of the semester, urging them to be creative and produce an eclectic, one of a kind prosthetic that could potentially fill a market niche.

When asked what he thought about the projects, Horne commented, “It’s amazing what this group has come up with at this level. It’s very innovative.”

In addition to the sophomore projects, freshmen participants designed and built cheap and effective heavy bag holders for use in mixed martial arts, juniors presented research on assistive rowing devices, and BME students showcased research on muscle stimulation systems for rowing.

Adapted from an article by Gregory Holt



Interest in sustainability powers new Electric Vehicle Club

The newly formed Electric Vehicle Club officially hits the road this spring thanks to a generous gift by the late Wallace Hutchinson McCurdy Jr., UD associate professor of chemistry and biochemistry. McCurdy had a passion for the environment, commuted by bicycle, powered his home via solar cells and had nearly built an electric car at the time of his death last fall.

Like its UD gas-powered sister club, Formula SAE (Society of Automotive Engineers), FSAE Electric is a student design competition in which undergraduate teams build a vehicle from the chassis up. In this case, however, the vehicle features an all-electric drivetrain and is battery powered and emission-free.

Faculty co-adviser, Ajay Prasad, Engineering Alumni Distinguished Professor and director of the Center for Fuel Cell Research, said interest in the electric vehicle club “caught on like wildfire,” not surprising based on the sustainability focus across campus by students, faculty and administration.

In their first act of going green, club members will recycle the chassis of a vehicle previously built by the FSAE club (teams in the gas-powered class may only use the same chassis for two years). Led by junior Benjamin Brust and nine other student club officers, the team will design and fabricate the remainder of the car including the battery pack and battery management system, and the complete electric drivetrain. The club plans to compete in 2015, but some FSAE Electric members will attend the 2014 competition to prepare.

The electric and gas-powered clubs’ synergy runs deeper than sharing a chassis. The teams share tools, learning experiences and even advice from ME instructor Steve Timmins, long-time faculty adviser for FSAE, and co-adviser of the electric team.

While start-up funds initially powered FSAE Electric, support is needed to sustain its momentum. To get involved contact Ajay Prasad at 302-831-2960 or prasad@udel.edu.



UD's Rossiny Beaucejour (left) and Krittika Madadi gave winning presentations at ABRCMS, the largest professional conference for minority students pursuing science, technology, engineering and math.

McNair Scholar earns top honors in biomedical research presentation

Senior Rossiny Beaucejour hopes to change the world by developing new “smart” materials embedded with tiny sensors that can monitor the materials’ structural health.

Beaucejour, a McNair Scholar, is well on his way, winning first place for his presentation at the Annual Biomedical Research Conference for Minority Students (ABRCMS) in Nashville, Tenn., last spring.

“My passion is to work on any project relating to nanotechnology,” said Beaucejour, who plans to pursue a doctoral degree in materials science and engineering.

ABRCMS—the largest professional conference for minority students pursuing advanced training in science, technology, engineering and mathematics (STEM)—is a major event for McNair Scholars. The primary goal of the program, one of 158 funded nationwide by the U.S. Department of Education, is to prepare students from underrepresented groups for graduate study – all the way to the doctoral degree.

Beaucejour’s research is titled, “Locally Patterned Carbon Nanotubes for Bio-Inspired Sensing of Deformation and Damage in Composite Materials.” His faculty mentor is Erik Thostenson, assistant professor of mechanical engineering.

Grad Students

Simulation challenge prize

Doctoral students Subramani Sockalingam and Raja Ganesh took first prize at the American Society for Composites (ASC) inaugural Student Simulation Challenge held last fall at Pennsylvania State University.

The goal of the competition, held during the annual ASC Technical Conference, was to see which student team could best predict the behavior of a composite laminate material that included a pattern of holes.

Composite laminates are consolidated layers of composite lamina that are valued for their strength and stiffness. The most commonly known is carbon fiber/epoxy, which is used in the aerospace and automotive industries to reduce weight without sacrificing strength.

“In the aerospace industry, the use of composite laminates is rapidly increasing due to their high strength, low weight and ability to be manufactured into complex geometries, among other factors,” said Sockalingam. “Of particular interest are structural components with discontinuities—holes and cutouts—which are often used to fasten structures together.”

However useful, Sockalingam continued, having a hole in a composite weakens the surrounding area and subjects the material to increased likelihood for failure under certain load conditions, important considerations in aerospace applications.

“Strength and failure are important design considerations for engineers to meet safety requirements,” he said. “You want to be able to predict accurately any failure because once it fails, it’s no good, so researchers try to prevent the damage through testing.”

Given limited data about the composite’s properties, competing teams were charged with calculating the maximum load the material could support.



The UD team ran two simultaneous simulations – one broad simulation to capture major data about the material’s performance, and another more detailed simulation to validate their predictions and accurately depict the material’s load carrying capability. Their results most closely matched those of the contest organizers, earning them first place in the competition, and a \$1,000 cash prize.

Sockalingam and Ganesh are advised by Jack Gillespie, director of the Center for Composite Materials (CCM), Donald C. Phillips Professor of Civil and Environmental Engineering, and professor of materials science and engineering and mechanical engineering; Bazle Haque, assistant professor of mechanical engineering; and Michael Keefe, associate professor of mechanical engineering.

Raja Ganesh (left) and Subramani Sockalingam (right)

Sockalingam’s CCM research focuses on modeling high performance polymer fibers and fiber-matrix interface subjected to high velocity impact, and bridging length scales from fibers to yarns. The third-year doctoral student hopes to pursue a research career in the automotive or aerospace industry, or at a national laboratory, and said the competition “helped us understand the kind of simulations one would conduct in the industry as part of the product development process”.

Ganesh, a first year doctoral student also conducting research at CCM, hopes to become a professor.

Article by Kevin Cella



SAMPE strong

Two material science doctoral students, both affiliated with the Center for Composite Materials and under the advisement of mechanical engineering faculty, won grand prizes for their presentations at last spring's Society for Materials and Process Engineering (SAMPE) international symposium and exhibition in Long Beach, Calif.

Jennifer Mueller, who is co-advised by CCM director Jack Gillespie, Donald C. Phillips Professor of Civil and Environmental Engineering, and professor of materials science and engineering and mechanical engineering; as well as by Professor Suresh Advani, took first place in Long Beach. As part of her prize, she was invited to present

Mechanical engineering has a strong presence at the Society for Materials and Process Engineering international symposium and exhibition, with two doctoral students winning grand prizes.

her talk, "Diffusion as a Bonding Mechanism for Ultrasonically Consolidated Metal Matrix Composites," at the SAMPE international conference in Nagoya, Japan, last November.

Qi An, who is advised by Erik Thostenson, assistant professor of mechanical engineering with a secondary appointment in the Department of Materials Science and Engineering, was the second-place winner. As part of her winnings, she will travel to Paris to present "Carbon Nanotube Reinforced Fiber/Epoxy Multi-scale Hybrid

Composites via Electrophoretic Deposition: Multifunctional Properties, Processing, Characterization and Modeling" at the international SAMPE conference this spring.

In addition, mechanical engineering senior Christine Gregg tied for first place in the undergraduate category in the SAMPE competition in Long Beach, and a team from CCM placed second out of 17 teams in the bridge competition.

Article by Diane Kukich



MECHANICAL ENGINEERING

Career Celebration & SENIOR APPRECIATION

MAY 9, 2014

*Don't miss the networking event
of the year for alumni, students,
faculty and industry partners!*

Mechanical Engineering's annual Career Celebration & Senior Appreciation Day—this year on Friday, May 9—brings together mechanical engineers from all industries and experience levels for an afternoon and evening of unparalleled networking. You will meet representatives from some of the most prestigious engineering firms on the east coast, many of who are Senior Design project sponsors; compare ideas and gather advice from colleagues; and reconnect with faculty members and fellow alumni who made your time at UD memorable. You'll also be inspired by the panel discussion featuring this year's Distinguished Career Award honorees, who hail from points as far east as Taiwan and as far west as Hawaii, share their connection with the department.

Plus, you'll get the chance to encourage and learn from today's engineering students as you learn about the department's Senior Design course, which teaches students how to take a project from "concept to reality" and see what it takes to put together an award-winning project.

"Great things happened last year when we brought these high achieving students and alumni together," said event co-organizer Jim Hutchison (ME1979).

All of this, and a *free dinner*, too! Come and meet some of the biggest names in the industry, update yourself with the latest research and technology, take a trip down memory lane and perhaps even make a connection that could set you on a whole new career path.

Don't miss out - add May 9 to your calendar now.

KEYNOTE SPEAKER:

**Distinguished Alumna
Terri Kelly, ME83
President and CEO,
W.L. Gore & Associates**



Kelly is a member of UD's Board of Trustees and is a former College of Engineering Advisory Council member and a former

Distinguished Career Award recipient. She serves on Nemours Foundation Board of Directors, and is a member of the Management Executive Society, G100 and the International Women's Forum.

Distinguished Career Awards

Congratulations to the following distinguished alumni who will be recognized May 9th for, among other things, their achievements, impact, uniqueness and interest.

YOU'RE INVITED:

Career Celebration & Senior Appreciation Day May 9, 2014

Clayton Hall Conference Center
Newark, Delaware.

- 1:00 &
1:30 p.m. Campus tours of ME facilities
leave from Clayton Hall
- 2:15 p.m. Reception & Sign-In
- 3:00 p.m. Welcome by Dept. Chair
Suresh Advani
- Senior Design Awards
- 4:00 p.m. Student Honors & Awards
- 4:30 p.m. Distinguished Career Awards
& Alumni Panel Discussion
- 5:45 p.m. Networking Reception
- 6:15 p.m. Dinner
- 7:30 p.m. Keynote Address,
Terri Kelly (ME83)
*President & CEO,
W.L. Gore & Associates*

Nelson S. Everhart III (B1968)

Nelson S. Everhart III (B1968) is a self-described change agent who specializes in creating order out of chaos when it comes to company operations.



This 1968 mechanical engineering graduate began his career as a project engineer for General Foods Corporation. He also served in the United States Air Force from 1969-1973 during the Vietnam War era, attaining the rank of staff sergeant E-5.

In 1975, Everhart joined Chesebrough-Pond's (now Unilever) as a senior project engineer. The company assigned him to the major shoe manufacturer, G.H. Bass & Company in the 1980s as director of engineering, then moved him to Canada where he served as vice president of manufacturing and technical services. In the late 1990s, he joined StarPlex Scientific as vice president of operations for the microbiological and specimen collection containers and pharmaceutical packaging company.

Everhart has spent more than the last decade building high performance teams, applying innovative technology to improve operations and directing change initiatives as director of quality assurance and plant manager of the Fiber Products Group of U.S. Cotton LLC/American Safety Razor Company, where he was recruited for his knowledge of good manufacturing practices and registered plant operations.

While hired to each subsequent position for his engineering-based knowledge of manufacturing, including budgeting, inventory, plant operations and quality assurance, Everhart's CV is similarly filled with examples of his success in team management, which he achieved by employing the ever-important, yet too-often-overlooked, principles of regular team meetings, active listening, staff feedback, mentoring and brainstorming.

Everhart is a member of the American Society for Quality, the National Council for Clinical Laboratory Standards, the Association of Laboratory Automation and the Society of Plastics Engineers.

Mehrdad N. Ghasemi Nejhad (MS1987, Ph.D.1992)

Among the many professional awards and accolades associated with Mehrdad N. Ghasemi Nejhad (MS1987, Ph.D.1992), perhaps the best conversation starter is his standing in the *Guinness Book of World Records (2007)* as



creator of the world's smallest brush. The nanotechnology expert and his team from the University of Hawaii (UH) Nanotechnology Laboratory created the device hailed by *NBC News* and *USA Today* as "boasting bristles a thousand times finer than a strand of hair used to sweep nano dust, paint small microtubes and clean pollutants in water."

When he's not in the world record spotlight, Ghasemi Nejhad chairs the Department of Mechanical Engineering at the University of Hawaii in Manoa, Honolulu. He also chairs UH's Accreditation Board for Engineering and Technology (ABET) for mechanical engineering and is the research team leader for the Integrated Research and Education in Renewable Energy and Island Sustainability program.

Ghasemi Nejhad earned a bachelor's degree in mechanical engineering from Sharif (Arya-Mehr) University of Technology in Tehran, Iran, in 1980 and garnered industrial experience at that country's Steam Power Plant in Karaj before coming to UD for his master's degree. He served as a graduate research assistant and DuPont Fellow, and earned a Ph.D. in 1992 based on research he conducted with the Center for Composites Materials. In 1993, he founded both a composites and smart structures lab at UH, and a decade later he founded the nanotechnology lab there, where his team created the infamous brush. He continues to direct all three programs. He also holds patents on Nanoresin- and Nanoforest-based nanocomposites and has related publications in *Nature Materials* and *Science*. He and his students won ASME-human powered vehicle national championships in 1995 and 1997. He believes that industrial practical experiences can be very helpful in academic success.

He is an ASME Fellow and a Boeing Welliver Faculty Fellow; has chaired ASME conferences on smart materials and multifunctional structures and on nanocomposites; and is associate editor of the *Journal of Thermoplastic Composite Materials*.

Pamela S. Lottero-Perdue (B1995; M.Ed. 1999; Ph.D. 2005)

Pamela S. Lottero-Perdue is putting the "E" in K-12 STEM education. This University of Delaware MEEG alumna (B1995) is associate professor of science education at Towson University. She is a former engineer and high school



physics and pre-college engineering teacher, and earned physics teaching certification and graduate degrees in science education from UD (M.Ed. 1999, Ph.D. 2005).

Lottero-Perdue applauds the inclusion of engineering within the new Next Generation Science Standards, yet also believes that more work is needed to ensure that teachers and students

have a robust understanding of engineering. "High quality K-12 engineering education is essential," she said, "not only to create a larger and more diverse STEM pipeline, but also to increase the technological literacy of our citizens, and to enhance students' learning of science, mathematics and other subjects."

In educating next-generation teachers, she includes engineering in her elementary and early childhood science methods courses, and teaches an engineering course she designed for those studying to teach middle school science. She has also developed an Engineering in Integrated STEM course as part of a program she directs for practicing elementary teachers.

Lottero-Perdue has acquired more than \$350,000 in funding to promote, support and study teacher and student engagement in engineering education in Maryland. She is currently a co-principal investigator on a multistate NSF-funded \$3M grant, "Exploring the Efficacy of Elementary Engineering," led by the Museum of Science, Boston.

Lottero-Perdue has served on a statewide workgroup to develop a STEM endorsement for elementary teachers, and on a national workgroup to develop standards for K-12 engineering education teacher preparation and professional development. She currently serves as chair-elect of the K-12 and Pre-College Division of the American Society for Engineering Education.

Gregory V. Selby (MS1979; Ph.D.1982)

Gregory V. Selby didn't view achieving his doctoral degree in mechanical and aerospace engineering as an end to his academic pursuits. Since earning his doctorate at UD in 1982, he went on to earn a bachelor's of science degree in psychology in 1990 from Old Dominion University, and, more recently, in 2012 earned a bachelor's degree in theology from Tripp Bible Institute. He earned his first bachelor's degree in aerospace engineering from the University of Virginia in 1971 and his master's from UD in 1979.



Selby's career achievements blend his love of aerospace engineering, academia and community service. He spent his

early career as a NASA aerospace engineer at Goddard Space Flight Center, Glenn Research Center and Langley Research Center, improving aerodynamics in the design of quieter, small aircraft. He then decided to help mold the next generation of mechanical and aerospace engineers as a member of the Old Dominion faculty, on which he has served now for 30 years, chairing the university's department in the early 90s and still serving as full professor today,

Selby annually visits schools to encourage students toward STEM careers and he created a science and engineering workshop series called the Institute for Young PHDs (Persons Having Dreams). He offers these workshops in the Hampton Roads, Va. area at no cost to students through support from local businesses and universities. He also mentors students from kindergarten to Ph.D. level, and is considered a role model for many minority and female students pursuing STEM majors and careers. He has written a book for parents based on his experiences – "How to Rear a Scientist or an Engineer."

As a religious leader in his community, he pulls from his engineering education to present thought-provoking seminars on science and religion.

Nyan-Hwa Tai (Ph.D.1990)

Nyan-Hwa Tai, who earned his doctoral degree from the University of Delaware in 1990, has recently advanced to vice president of academic affairs for National Tsing-Hua University (NTHU) in Taiwan. A full professor of materials science and engineering, he joined NTHU faculty in 1998 as an associate



researcher in the Center for Materials Science. His academic appointments include department vice chairman and chairman, deputy dean and acting dean of the College of Engineering, and associate vice president of academic affairs. He also served as a visiting scientist at Oxford University in England in 2007.

UD sparked Tai's interest in composites research, which then extended to

carbon fiber composites, carbon nanocomposites, carbon/carbon composites, carbon nanotubes, graphene and ultra nanocrystalline diamond, as well as interference shielding, heat dissipaters, flexible transparent conductive films and electrodes, super capacitors and photothermal therapy of cancer cells. He credits UD's interdisciplinary environment with enabling him to switch his research focus from ceramic to polymer matrix composites, and then to other advanced materials without difficulty. He says his UD education provided the foundation for his post-graduate research and enabled him to meet the challenge of developing innovative studies. He has authored more than 75 journal papers and holds 12 patents from Taiwan and the United States.

While studying in Newark, Tai attended six international conferences and, in 1989, visited the U.S. Department of Energy's Oak Ridge National Laboratory in Tennessee, with all of his expenses supported by the Department of Mechanical Engineering and the Center for Composites Materials. In turn, he has spent his career encouraging his NTHU students to study abroad. In fact, between 2005 and 2010, MIT's Department of Materials Engineering accepted at least one graduate student each year from Tai's department, which has advanced to one of Taiwan's top 10 departments in science and engineering under his leadership. Tai is also committed to recruiting and securing financial support for students from low-income families.

"The UD MEEG interdisciplinary research program inspired me and shaped my diverse way of thinking," said Tai.

Young alumni profile: Mark Neuman



When the fuel tank in your car gets low, all you have to do is pull into the nearest gas station and fill it up. But what happens when a \$100-million satellite starts to get low on fuel? That's a much bigger problem – one that an entire team of engineers has been charged with solving in the Robotic Refueling Mission (RRM).

For UD-ME alum **Mark Neuman**, being a member of the RRM team is just the latest assignment in a career with Orbital Sciences Corporation that began when he graduated in 1987. Located in Greenbelt, Md., near the Goddard Space Flight Center, the company provides systems that enable or enhance space and defense operations.

For more than a quarter century, Neuman has worn many hats in supporting NASA's human space flight projects – designer, analyst, astronaut interface representative, robotic systems engineer and project lead systems engineer. He currently supports NASA's Satellite Servicing Capabilities Office at Goddard.

"I always knew that I wanted to be involved with the space program," Neuman said. "I grew up in the age of the moon missions, Star Trek and the space shuttle, and it all fascinated me."

Neuman began his career in satellite servicing working on the most famous NASA satellite – the Hubble Space Telescope.

During five space shuttle missions spanning 16 years, Neuman helped to design and develop the special tools and handling aids the astronauts used to replace scientific instruments and critical components on Hubble.

"It was neat to see representations of the hardware I developed in the shuttle cargo bay at the beginning of the movie *Gravity*," he said.

When the shuttle program ended in 2011, the ability to service satellites via spacewalking astronauts also ended. So Neuman turned his attention to training robots.

The RRM is a demonstration payload on the International Space Station that is a pseudo outer space "gas station" using the onboard Canadian robot "Dextre" as the attendant. Using special tools on RRM, the dual-armed Dextre has successfully removed caps, cut wires and actually transferred fluid to a simulated satellite portion of RRM.

"Dextre was controlled by robot operators in Houston, and these tasks were completed while the Space Station astronauts were sleeping or doing other chores," Neuman said.

The lessons learned using RRM are laying the foundation for dedicated robotic missions to service satellites in much higher orbits.

"In most cases, these satellites were not designed to be serviced, so it takes a lot of attention to details as well as a team effort from engineers of all types to get the job done," Neuman said.

As the lead systems engineer for RRM, Neuman and his team are currently working on RRM Phase 2, which adds more robotic tools and satellite interfaces for Dextre to practice on.

Neuman lives in Columbia, Md., but spends a fair amount of time in Houston. He is certified to SCUBA dive in NASA's Neutral Buoyancy Laboratory, a 100 ft. by 200 ft. by 40 ft. deep swimming pool where a full-size replica of the space station is submerged for crew training and task evaluations.

Although he has been out of school for almost 27 years, Neuman still has fond memories of the ME senior design course. "The design review process we learned at UD proved to be an invaluable experience for the numerous design reviews we go through for every NASA project," he said.

Neuman has received many awards for his engineering work, but his interests go far beyond his life as an engineer. He plays guitar in a local band as a hobby and just completed his first season as guitar player for the Baltimore Ravens marching band rhythm section.

Neuman's wife of 25 years, Samantha Cranmer Neuman, is also a UD alum. She earned a computer science degree in 1987 and currently keeps busy with their four teenage children.

Investigating spinal disc herniation, failure Down Under

Recent mechanical engineering graduate Dhara Amin (B2013) is spending a year Down Under conducting research on spinal disc herniation at Flinders University in Adelaide, Australia.

Herniation occurs when the fibrocartilage, a weight-dispersing cushion extending through the center of the spinal discs, ruptures. According to Amin, lower back pain affects more than 70 percent of people during their lifetime, and is the fifth most common reason people seek medical care. It often develops from work activities that involve repetitive lifting or loading.

Amin is assisting John Costi, senior lecturer of biomechanics research at Flinders University, with his research examining the failure mechanisms, or internal strains, that lead up to disc herniation.

Using a novel device designed by Costi called a hexapod robot, the team will simulate six loading conditions, including tension, compression and bending. The researchers will repeatedly subject lumbar spine segments to motion and loading to identify specific repetitive movements that cause the greatest strain to spinal tissues. Sensors embedded in the discs prior to the simulation will measure internal tissue strains and yield a 3D model of the disc segments for further analysis.

“We hope to identify early indicators of herniation, which could help prevent and treat such injuries in a clinical setting,” said Amin.

Amin first became involved with spinal disc research in 2011 when she began collaborating with Dawn Elliott, professor and director of UD’s biomedical engineering program, and Brent Showalter, a doctoral candidate, in UD’s spine biomechanics



research lab. The team tests the repetitive motion and loading mechanics of spines that have undergone a nucleotomy to simulate a herniation following a new implant treatment to replace the lost tissue.

Amin, who learned about Costi’s research at Flinders from Elliott, was accepted into the Whitaker International Fellows, a program dedicated to helping young biomedical engineers gain academic and laboratory experience outside of the United States.

After the fellowship, Amin plans to study the clinical applications of biomedical research. Her long-term goal is to become a surgeon while running her own orthopaedic research lab.

“I believe that there is a strong connection between clinicians and engineers,” she said. “Without either, I do not think that the biomedical engineering field would be as prominent as it is today.”

Article by Sarah E. Meadows

Discovery learning

Dear ME Alumni and Friends,

One of my first campus tours as the College of Engineering's new development director was a visit to the Design Studio in Spencer Lab. Among the many real-world problems I witnessed students tackling that day was a vest with a built in alarm that can alert nursing students to mistakes than can harm patients. The vest will be worn by actors assisting nursing students when practicing patient care. No simulation lab actor could provide such timely or potentially lifesaving feedback without this technology. I was so impressed with these young mechanical engineers and their ability to create innovations with the potential to address real challenges facing our world today. And this was just one example of what's happening in this transformative facility that is already attracting students and faculty from around the nation.



Similar to the Interdisciplinary Science and Engineering Laboratory and the STAR Campus, the Design Studio provides hands-on opportunities to translate students' academic knowledge into practical experience in a unique learning environment. While the Design Studio is fully functional, we continue to need your financial support to expand the work space and equip it with the most advanced tools and technology. Imagine having had such a place to design and create when you were studying mechanical engineering! Just think what societal problems these young engineers will be able to solve having trained within its walls...



I encourage you, as alumni and now accomplished engineers yourselves, to consider giving back to the school which afforded you a quality education and many career opportunities. Whether you choose to make a gift to advance the promise of ME's new Design Studio; provide scholarship funding to help offset the rising burden of education faced by today's students; or create an endowment to help attract and retain the best and brightest faculty to ensure UD's position as a top engineering school, your philanthropic support today will help mechanical engineers solve problems of tomorrow.

I look forward to helping you continue or re-establish your connection with your alma mater. What societal challenges are you ready to help resolve?

Barbara Maylath
Director of Development
College of Engineering

Barbara Maylath joined COE last November as the new director of development, succeeding Armand Battisti, who retired last summer. Barbara comes to UD from careers in both academia and health care, most recently with the University of the Sciences in Philadelphia; Rutgers The State University of New Jersey Law School; the United Way of Gloucester County (NJ); Deborah Hospital Foundation and the American Heart Association. We are delighted to have Barbara on board as we build strategic partnerships to help COE alumni and friends stay connected.

You can send Barbara a welcome message via e-mail to bmaylath@udel.edu or by calling 302-831-7273.

Spotlight on Ken Ryder, B1986

Ken Ryder has more than a quarter century of research and development and medical device experience in mission-critical and life-sustaining products and technologies, having worked for Johnson & Johnson and its Cordis Corporation on both coasts. He has recently moved back east to Boston where is now senior director of global engineering for Abiomed, manufacturer of temporary cardiac assist devices.

A 2012 Distinguished Career Award honoree, Ken serves on the Mechanical Engineering Advisory Council and is an active alumni contributor.

Here, he explains the inspiration behind his recent gift to help undergraduate ME students get the foundation they need for successful engineering careers, and why he encourages his fellow Blue Hen alums to get involved, as well.



MEEG: What is the greatest challenge faced by engineers today?

RYDER: The demands of the workplace are very dynamic requiring engineers to be equally flexible and adaptable. Assignments can change on a dime; sometimes what seems like a bad assignment is a blessing in disguise. It is rare that one can spend a career in a single technical area – engineers must be able to lead projects, teams and organizations as well as contributing technically. Whatever you do, excel at it and good will come.



MEEG: How can UD best prepare tomorrow's engineers?

RYDER: Tomorrow's engineers will need a balance of technical skills, leadership skills and business acumen to excel. Delivering curriculum that blends strong academic training, hands-on application and experience in business decision-making and leadership is key to enabling their future.

MEEG: What inspired your gift of the Ryder Family Scholarship in Engineering?

RYDER: Attending UD was a life-changing event for me – new doors of opportunity were opened. I used Air Force ROTC to fund my college education. With this gift, I wanted to provide the opportunity to help open doors for others where military service was not desired.

MEEG: What are your words of encouragement for fellow alumni considering reconnecting with UD?

RYDER: Take stock in where you are in your life today and you will likely find a strong connection to UD that has been a key to your success. Nurture that key connection—find a way—because it helped you, and whether you realize it or not, it is an underlying passion. Pursuing our passions makes us happy and whole.

MEEG: What career or life advice would you share with each engineering graduate as he or she leaves UD to enter the workforce?

RYDER: You get what you expect and you deserve what you tolerate. Set high expectations for yourself, for your supervisor and for your colleagues, and manage these accordingly. Be accountable for your own success.

Thank you alumni donors!

We wish to thank the many friends and alumni who have made generous contributions over the past year. Your gifts are used for many worthwhile purposes, including support of our research and educational programs. To make a donation, please visit UD Connection (www.udconnection.com) and click Donate Today. If you wish to designate your gift to ME, select other from the list provided, then specify Mechanical Engineering.

July 1, 2012–June 30, 2013

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