University of Delaware

Mechanical Engineering News

Engineering Sustainability

Cheers from the Chair

This has been a year of unprecedented growth for Mechanical Engineering at the University of Delaware. Our research funding has never been larger and our undergraduate student body for next fall will be the largest in our history!

Our research funding has been especially strengthened by receiving our second NIH Center of Biomedical Research Excellence (COBRE) award. This $11 million grant from the National Institutes of Health to our Center of Biomedical Engineering Research recognizes the excellent work we are doing in osteoarthritis research. This particular award also recognizes our efforts to promote women in engineering and science and involves projects led by two of our youngest faculty members: Drs. Liyun Wang and Jill Higginson.

Our undergraduate enrollment has increased substantially. This year we are revising our introductory course by offering a new course that introduces students to all aspects of engineering (not just mechanical). The plan is to have this course be taken by all engineering undergraduates so that they will not necessarily have to declare which discipline within engineering they wish to study before they begin their academic careers at the University of Delaware. Because we now have so many "undeclared" incoming students, it is a bit difficult to ascertain how large our ME freshman class ultimately will be, but it appears to be close to 50% larger than last year.

One of the attractions of our program may be the new minor in biomedical engineering that we are beginning to offer this fall. We are also exploring other minors that may be attractive to our students.

We have had some interesting changes in our faculty this year. Several of our longest tenured faculty members have announced their retirements. Drs. Andras Szeri, Mike Greenberg, and Dick Wilkins are in the process of slowing down (some faculty members never really retire and still stay involved in their research activities). On the other hand, we were especially pleased to have brought onboard Dr. Bingqing Wei this last January. He came to us from LSU as an associate professor. Drs. Wei's area of expertise is nanomaterials—an exciting area of research that will compliment our great work in composites. We are also looking to add several new professors to our ranks next year.

Many Mechanical Engineering programs are struggling, but ours has been thriving. It is great to be a part of such a rich academic environment!

Thomas S. Buchanan

Chair of Mechanical Engineering

Inside This Issue

ME News
Managing Editor—Nate Cloud
Contributing Writer and Editor—Diane Kukich

Editor's Notes:

The Alumni Career Celebration program for 2007 culminated in our 3rd Business, Technology. And Careers Conference at Clayton Hall on April 27th. News coverage of the event is on pages 6–10 of this newsletter, and more pictures of the event and seminar presentations are posted on the UDME Alumni website www.udel.edu/alumni.

220 alumni, students, and faculty attended the 4/27 conference at which six alums where honored with the "Distinguished Career" citation, bringing the total alums so honored to 21. All of the feedback on this program from participants has been positive, and constructive, looking toward continuous improvement.

We have already put a hold on Clayton Hall for April 25th, 2008, and we want to find ways to increase alumni participation. 57 alums attended the conference, but since there are over 2800 UDME alums globally, and approximately 1600 living in Delaware and contiguous states, we think there is good potential to increase participation. The program planning team is re-convening this summer, and we plan to develop ways to facilitate your input, but of course we'd appreciate hearing from you at any time during the year.

Faculty & Staff Highlights

Tsu-Wei Chou, Pierre S. du Pont Chair of Engineering, delivered an invited lecture at the 5th International Symposium on Nanotechnology, held from February 20–21, 2007, in Tokyo. The conference is the biggest event in Japan for nanotechnology, and Chou was one of only 12 speakers invited to make a presentation. He spoke on electro-mechanical behavior of carbon nanotubes and their composites. Chou also presented the Newton C. Ebaugh Lecture at the Mechanical and Aerospace Engineering Department of the University of Florida on March 6; gave an invited lecture at the 17th US Army Symposium on Solid Mechanics in Baltimore, Maryland, on April 5, and delivered an invited lecture at the 3rd China-Europe Symposium on Reinforced Polymers in Budapest, Hungary on June 14. Chou's innovative work on the use of carbon nanotubes as distributed sensor systems for damage detection and structural health monitoring of fiber composites (reported in the last issue of *ME News*) has received much attention worldwide and resulted in two more research grants from the Office of Naval Research.

Kausik Sarker has been awarded two three-year NSF grants. One of them is for computational modeling of leukocyte (white blood cell) adhesion to blood vessel walls. The other will support experimental characterization and modeling of functionalized microbubble contrast agents used for ultrasound imaging and drug delivery. He is also co-PI on an NIH grant to ultrasonically measure pressure using subharmonic signals from contrast microbubbles.

In addition, Sarker gave three invited talks, one in the Department of Mathematics at the New Jersey Institute of Technology, the second at the Center for Fluid Mechanics, Turbulence and Computation at Brown University, and the third at the 27th Leading Edge in Diagnostic Ultrasound Conference in Atlantic City, NJ.

Sarker's student Xiaoyi Li received the 2007 Allan P. Colburn Prize for the outstanding doctoral dissertation in Mathematical Sciences and Engineering. The work addressed the problem of characterizing the interface between two moving fluids. The dissertation has already resulted in five papers published in prominent journals, and additional papers are under preparation.

Sarker and Anette Karlsson have been promoted to Associate Professor.

Department Chair **Thomas S. Buchanan** is the PI on an $11M Center of Biomedical Research Excellence grant from the National Institutes of Health (see article on page 3).

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Department News

UD Receives $11M NIH Grant for Osteoarthritis Research

Editor's Note: This article was adapted from an article by Tracey Bryant that appeared in UDaily *on June 14, 2007. A related story on Jill Higginson's research appears on page 4 of this issue of ME News.*

The University of Delaware has been awarded $11 million from the National Institutes of Health for leading-edge, "translational" research on osteoarthritis that includes a unique mentoring program to foster the development of women biomedical researchers at UD.

The grant, led by Thomas Buchanan, professor and chair of ME, is the second, five-year award to UD's Center for Biomedical Engineering Research from NIH's Centers of Biomedical Research Excellence Program. The center received a $6.4-million grant in 2002.

The wearing down of cartilage, the natural cushion between the bones and joints, causes osteoarthritis, the most common form of arthritis. The disease typically affects the knees, hips, back and hands.

According to Buchanan, the latest grant will enable UD to continue building the infrastructure and expertise to address the mechanisms of osteoarthritis and its prevention and treatment by examining the disease from the integrated perspectives of tissue mechanics, biomechanics, physical therapy, and clinical intervention.

The program will involve 14 faculty in three of UD's seven colleges, including not only ME but also the Departments of Biological Sciences and Physical Therapy in the College of Arts and Sciences, as well as the Department of Health, Nutrition and Exercise Sciences in the College of Health Sciences. Researchers from the Alfred I. duPont Hospital for Children and the Kessler Medical Rehabilitation Research and Education Corporation will serve as collaborators.

"What we have at UD that's really unique is a collection of people to address osteoarthritis across multiple levels, which is what translational medicine is all about," Buchanan said.

"We have people who can look at the proteins that are important to the healing of cartilage, for example, to people who can create biomechanical models showing the movement of bones and joints, to people who can conduct the clinical studies critical to the development of therapies. We can span lots of disciplines, which is what's exciting here," he noted.

Buchanan said the program's focus on mentoring women in science and engineering evolved after the request for research proposals was circulated at UD. Women faculty submitted the top-five research proposals.

"We wanted to find ways to use this program as an opportunity to promote their role," he noted.

Nationally, women continue to be underrepresented in the academic ranks of science, technology, engineering, and mathematics. At UD, the percentages of all tenured/tenure-track women faculty are 17% in the natural sciences and 10% in engineering, according to Buchanan.

"Mechanical engineering, for example, traditionally has been a male discipline although many of our new faculty are women," Buchanan said. "Our goal is to find good faculty mentors and start working with these new hires to see the discipline change. We need more, better mentoring to help with the process."

The grant's chief components, Buchanan said, are to create a core facility for mentoring women in science and engineering, to establish a new lab focusing on cytomechanics, or cell mechanics, and to advance five integrated research projects in osteoarthritis.

Women faculty, including two from ME, are directing the grant's five research projects. Senior faculty leading two of the projects are helping to mentor the junior faculty in charge of the remaining projects.

ME Assistant Professor Jill Higginson is investigating the muscle forces and coordination strategies used during walking in individuals with age-related osteoarthritis of the knee. A combination of MRI, gait analysis, electromyography, and biomechanical modeling and simulation will be employed to determine the most effective non-surgical interventions.

Liyun Wang, also Assistant Professor of ME, is exploring the pathway of communication between bone and cartilage. Experiments have shown that bone cells from osteoarthritic patients can cause cartilage to break down. Wang is combining lab techniques with mathematical modeling to characterize the movement of molecules through bones in normal and osteoarthritic joints.

The other projects are led by Mary C. Farach-Carson, Professor of Biological Sciences and Director of UD's Center for Translational Cancer Research; Lynn Snyder-Mackler, Alumni Distinguished Professor of Physical Therapy and Director of the Graduate Program in Biomechanics and Movement Sciences at UD; and Katherine Rudolph, Assistant Professor of Physical Therapy.

Tom Buchanan is leading a major NIH-funded osteoarthritis program that includes (from left in back) Katherine Rudolph,, Lynn Snyder-Mackler, and Catherine Kirn-Safran; (from left in front) Cindy Farach-Carson, Jill Higginson, and Liyun Wang.

Jill Higginson: Osteoarthritis Studies Lead to Better Therapies

Assistant Professor Jill S. Higginson, who joined the UD faculty in 2004, was attracted to Delaware's biomechanics program. "I liked the strong foundation in engineering, which is complemented by the opportunity for collaboration with investigators in the departments of Physical Therapy and Health & Exercise Science," she says.

Her expectations were borne out, as Higginson has found a very supportive environment for her work in neuro-musculo-skeletal biomechanics through ME's Center for Biomedical Engineering Research (CBER).

Higginson and her research group are working to improve understanding of muscle coordination in normal and pathological movement through coupled experimental and simulation studies. "We hope to develop a cause-and-effect framework that relates muscle impairments to gait deviations and ultimately form a scientific rationale for therapeutic interventions," she says.

A 2002 grant to UD from the National Institutes of Health (NIH) through its Center of Biomedical Research Excellence (COBRE) program has provided significant funding to create infrastructure and expertise to address the mechanisms of osteoarthritis and its prevention and treatment. Although Higginson was still a Ph.D. student at Stanford when UD received the COBRE grant, she has benefited from the support.

She is also a member of a faculty team that was recently awarded a five-year $11-million COBRE grant. The all-female team includes two faculty members from ME, two from Physical Therapy, and one from Biological Sciences (see related story on page 3).

Higginson's lab includes a dual-belt treadmill with force plates that collect multiple readings over continuous cycles. She and Ph.D. student Joe Zeni are currently using it to study the effect of asymmetry on muscle coordination in patients with osteoarthritis (OA). Zeni is collecting and analyzing data to document the effect of OA's progression on biomechanical factors such as strength and muscle contraction.

Subjects are asked to walk on the treadmill at two settings—a speed that is comfortable and one that is as fast as they can go. "We want to see what happens when they're challenged," Higginson says.

She and her students have developed a computer simulation that predicts how much force OA subjects exert through the knee when they walk. The simulation is important, as this force cannot be measured directly because the muscles are also contributing. The researchers hope to find the answers to several questions: What compensatory measures do OA patients use? Do they use their muscles differently from normal subjects? Do they change their gait pattern to reduce the forces?

Zeni is also looking at the effect of muscle co-contraction—i.e., of the front and back of the knee. "The more co-contraction you have," Higginson says, "the more compression there is in the joint."

Although the results are preliminary, Higginson and Zeni have found that there are changes across the stages of arthritis. "Co-contraction enables stability, but it also increases loads on the knee, which is detrimental over time," Higginson explains.

"We can promote good compensatory patterns through PT and strength training," Higginson says. "But from a biomechanical viewpoint, we need to at least know how forces are affecting the progression of OA." She views such strategies as an important component in a suite of therapies, including medication, to treat OA.

Higginson has plans for a new study that will investigate changes in cartilage over time. She is also looking forward to the opportunities that will be afforded through the new COBRE funding. Her colleagues on that project include Liyun Wang in ME, as well as Lynn Snyder-Mackler and Katherine Rudolph in PT and Mary Farach-Carson in Biological Sciences.

Editor's Note: Prof. Higginson is seeking subjects for her osteoarthritis study. If you are between the ages of 40 and 75 and can walk on a treadmill for 8 minutes, you may be eligible to participate. For participating in the study, you will receive a free analysis of your leg strength and an analysis of your walking pattern that has been reviewed by a physical therapist. For more information, contact Joe Zeni at (302) 831-0759 or jzenijr@udel.edu.

Santare and Karlsson Part of Fuel Cell Team

Editor's Note: This article was adapted from an article by Neil Thomas that appeared in UDaily *on March 27, 2007.*

Prof. Michael H. Santare and Associate Professor Anette M. Karlsson, both in the Department of Mechanical Engineering, are part of a team headed by Nuvera Fuel Cells Inc. of Cambridge, Mass., that has won a $5 million U.S. Department of Energy grant for research and development of fuel cells.

The funding will support UD research on polymer electrolyte membrane fuel cells (PEMFCs), which Santare said have many potential benefits for transportation applications. Among those benefits are increased fuel efficiency, lowered harmful emissions, and a reduction of the world's dependence on petroleum.

However, Santare said there are still a number of technical barriers that must be overcome before PEMFCs can be commercially successful on a large scale. One of the most challenging issues for PEMFC-powered vehicles is start-up and shut down in low temperatures.

Because water transport through the membrane is an essential part of the operation of the fuel cell, sub-freezing temperatures can impose large stresses on the system as the water freezes, Santare said. These stresses in turn can cause premature mechanical failure of the fuel cell. Furthermore, if water remains in the system after shut down, it could freeze and further stress the system.

"The need for improved lifetime of PEMFC necessitates that the freeze-thaw behavior be understood clearly and that mechanical models be developed so that new materials and system designs can be introduced to improve the cold temperature performance," Santare said.

"In automobile applications, the requirement on durability is very high," Karlsson said. "We don't expect to

have to take the car in for service once a month. In fact, we don't expect to have to do anything to maintain the car. To ensure a reliable design of a fuel cell, we must therefore understand how it behaves over a long time, for all possible conditions. The fuel cell gets frozen several times during the winter and might run very hot during operation in the summer. Each extreme event accumulates a small damage and we must interpret this damage into our models to predict how the material degrades with time."

She said the grant "is an important addition to the ongoing and growing effort in the mechanical engineering department on clean energy, where more than half a dozen faculty members are actively conducting research."

In addition to Nuvera and UD, other partners in the project are W.L. Gore & Associates and SGL Carbon Inc.

Santare has research interests in applied mechanics and composite materials. He received a bachelor's degree from Rensselaer Polytechnic Institute and a master's and a doctorate from Northwestern University. He joined the UD faculty in 1986 and was a Fulbright Distinguished Visiting Professor at the Universidade do Porto in Portugal in 2001.

Karlsson has interests in the thermomechanical properties and response of advanced and traditional materials. She received a doctorate in mechanical and aerospace engineering from Rutgers University and conducted postdoctoral research at Princeton University before joining the UD faculty in 2002. She is the recipient of the 2004 Office of Naval Research Young Investigator Award and the 2005 Francis Alison Young Scholars Award.

Two faculty members from the UD Department of Chemical Engineering, Jingguang Chen and Brian Willis, are part of another team that has received Department of Energy funds to work on fuel cell technology. That effort is directed at finding ways in which hydrogen fuel cells can be made less costly and more stable by using materials such as tungsten carbide modified with low concentrations of platinum instead of pure platinum.

"The Department of Energy is committed to breaking our addiction to oil by creating a diverse portfolio of clean, affordable and domestically produced energy choices," U.S. Energy Secretary Samuel W. Bodman said in announcing the award, part of $100 million in grants announced by the agency. "We expect hydrogen to play an integral role in our energy portfolio, and we are eager to see hydrogen fuel cell vehicles on the road in the near future."

Agrawal Receives Humboldt Award

Editor's Note: This article was adapted from an article by Neil Thomas that appeared in UDaily *on May 3, 2007.*

ME Professor Sunil K. Agrawal has received the prestigious Humboldt Research Award for Senior U.S. Scientists from Germany's Alexander von Humboldt Foundation.

The Humboldt is one of the top research awards given by the German government to renowned scientists and scholars from throughout the world. It recognizes the lifetime achievements of the recipients.

The award, presented to 100 senior scientists annually, provides funding to enable recipients to spend time in Germany studying with counterparts in their various research fields.

"I was very surprised, and also very honored, to receive this award," Agrawal, who conducts internationally recognized research in robotics, said.

Oliver Sawodny, a professor at the University of Stuttgart, one of the premier technical universities in Germany, nominated Agrawal for the award. Agrawal plans to visit Germany this summer and will spend periods of time there over the next two years while continuing to teach and conduct research at UD.

The laudation from his hosts, Sawodny and Lothar Gaul, also a professor at Stuttgart, states, "Agrawal is internationally recognized for his outstanding research in the area of methods based on differential flatness for non-linear systems. He has made important contributions to the systematic design procedure and for the problem of trajectory generation based on optimization strategies."

Agrawal is an expert in robotics and currently is conducting research into "how to make machines run, walk, and fly with only a few actuators," for their movement and control.

"This is an area of much interest to us, and we have been working on it for last 10 years," Agrawal said. "We hope to make additional advances as we work with our colleagues in Germany."

While in Germany, Agrawal will be provided an opportunity to meet the German president, currently Horst Kohler, at the Bellevue Palace in Berlin.

This is the second major award Agrawal has been presented by the Alexander von Humboldt Foundation. Four years ago, he received the organization's Friedrich Wilhelm Bessel Research Award, for younger researchers who have made significant impact. He was also an Alexander von Humboldt Research Fellow in 1994 and 1995.

In addition, Agrawal was a recipient of a National Science Foundation Presidential Faculty Fellow Award from the White House in 1994.

Agrawal received his doctorate in mechanical engineering in 1990 from Stanford University, where he was a research assistant in the University's robotics laboratory. He taught and conducted research at Ohio University from 1990 until 1996, when he joined the UD faculty.

He received his bachelor's degree from the Indian Institute of Technology in Kanpur and his master's degree from Ohio State University.

University of Delaware
Mechanical Engineering News

Business, Technology & Careers Conference

Friday, April 27, 2007

at the
Clayton Hall Conference Center
at the University of Delaware

Third ME Business and Careers Conference a Success

Some 225 alumni, students, faculty, and guests attended the third annual ME Business, Technology, and Careers Conference at Clayton Hall on Friday, April 27. "We're pleased that attendance had risen every year," said coordinator **Nate Cloud**. "It's increased by about 50 percent since our first event, in 2005."

Cloud and the other conference planners are also pleased that student involvement has increased since the first year. That trend has been facilitated by having two students, a junior and a senior, on the planning committee.

"This year's conference was very successful," said committee member **Khenya Still** (BME2007). "I've been hearing great feedback from the students on the alumni they networked with and also the workshops presented. We changed the structure of the discussion panel this year to dive deeper into the lives of our Distinguished Career alumni, which I found to be intriguing. I enjoyed being able to see where I can possibly take my mechanical engineering degree in the future. I look forward to attending this conference as an alumnus in the years to come."

Feedback on the Conference was generally positive. One attendee summed it up: "It was a well planned event, the facility was quite suitable, the format with split sessions was good and the presentation topics were interesting, and the opportunity for networking was great."

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Image

A Business,
& Careers

Faculty

Friday, Apr

Students

s from

Technology Conference

ril 27, 2007

Program Planning Team

Speakers & Alums

The talks

Associate Professor **Lian-Ping Wang** delivered a multifaceted presentation on environmental fluid mechanics, an area of study that addresses naturally occurring fluid flows of air and water on the earth. Examples include sea breezes and tidal currents.

The topic has significant overlap with other disciplines including meteorology, climatology, hydrology, hydraulics, limnology, and oceanography, Wang said.

Scientific methods used in environmental fluid mechanics include field observation, laboratory experimentation, theory, and computer simulation.

Wang studies clouds and precipitation because they contribute to the water cycle on earth, which in turn has an impact on global warming. Clouds represent a source of significant uncertainty in numerical weather prediction and climate models, so developing accurate simulations is important.

Wang reviewed work that he is doing in collaboration with scientists throughout the world, including Wojciech Grabowski at the National Center for Atmospheric Research (NCAR), G. He at the Chinese Academy of Sciences, and Alberto Aliseda at the University of Washington. He also works with other researchers at UD in ME and plant and soils sciences.

In addition, Wang provided highlights of work being carried out by faculty in UD's Department of Civil and Environmental Engineering, including its Center for Applied Coastal Research; the Department of Geography; and the College of Earth and Marine Studies. The work ranges from modeling of tsunamis and coastal disaster prediction and mitigation to investigations of wetlands and water quality.

Activities at UD are expanding in the area of environmental fluid mechanics, with the University already designated a sea, space, and land grant college and joining the University Corporation for Atmospheric Research (UCAR) this year.

Wang's take-home message? "Environmental fluid mechanics has many exciting applications and interdisciplinary complexities," he said. "We have to learn to talk others' language and to cross the boundary of mechanical engineering."

Although the windmill concept is more than 1,000 years old, wind energy is a topic that is receiving lots of media attention as fuel costs rise and fuel supplies dwindle. Two of the speakers at the ME event spoke about wind energy.

Prof. **Len Schwartz**, who has been teaching and conducting research in the area of fluid mechanics for more than three decades, has recently embraced a new interest: wind energy. This spring, he began teaching an elective course on that topic, and he spoke to ACC attendees about it as well.

Schwartz began with a historical perspective, showing pictures and explaining the principles behind windmills used between 1500 and 1900. Early uses were primarily agricultural, with the mills being used to keep lowlands dry in the Netherlands and to lift water from wells in North America and Australia. The first modern turbine was the Danish Gedser, which was created in 1957 and ran for 11 years without maintenance.

Schwartz reviewed various wind turbine concepts and explained the Betz Theory of Maximum Achievable Power. According to this theory, not all power can be extracted, and flow slows down when power is extracted, and the "stream tube" expands. The more expansion, the less wind is used.

According to Schwartz, "The way forward is to improve the bottom line." The National Renewable Energy Laboratory (NREL) advocates airfoil improvements and "micro-siting." Changes in airfoil shape can improve efficiency at negligible added cost, while micro-siting also includes relative positioning on a wind farm. "Both of these are fluid mechanics problems," said Schwartz. "Lucky me."

Schwartz acknowledged that wind can never be an exclusive source of energy for electricity, but interconnected wind farms can reduce fluctuations. Another solution, which is being used in Tasmania, is integrated wind and hydropower. "When the wind blows, hydro energy is stored; when the wind is calm, hydro energy is used," Schwartz explained.

Willett Kempton, Associate Professor in the College of Marine and Earth Studies (CMES) at the University of Delaware, delivered the keynote lecture on "Wind Energy Offshore: Resource, Policy and the Path Forward."

Kempton is part of UD's Offshore Wind Group, which is centered in CMES and also includes faculty from ME, geography, and policy, The group collaborates with scientists across the U.S. and Europe and is currently funded by the Delaware Energy Office and Sea Grant. A major increase in support from federal sources is anticipated to assess the entire Eastern Seaboard.

Alternative energy sources are important, Kempton said, to reduce dependence on foreign supplies, promote economic development, and reduce emissions. The biggest problem, climate change, requires some 60 to 80% CO_2 reduction in 40 years.

A proposed offshore Delaware wind farm, Bluewater Wind, has the potential to contribute significantly to meeting the State's needs for electricity. While there is little windpower on land, Kempton pointed out, the dense urban corridor from Boston to North Carolina is home to many cities close to the coast that could benefit from offshore wind.

While windpower has tremendous potential, Kempton acknowledged that there are problems associated with it, including public opposition to the change in familiar landscapes, the mismatch between power fluctuations and load fluctuations, and avian deaths. One poll conducted, however, shows that Delawareans overwhelmingly prefer offshore wind to coal or natural gas, even if wind costs slightly more initially.

Kempton cited statistics showing that concerns related to avian deaths are largely unfounded. The vast majority of birds, he said, just fly around the turbines, and fossil sources typically cause far more deaths—in humans as well as birds.

In concluding with "the path forward," Kempton said that CO_2 policies will create many opportunities for new technologies and businesses. In Delaware and the coastal Atlantic, offshore wind could be a dominant power source. Finally Kempton emphasized that planning the path forward will take engineering, geophysical fluid dynamics, law and policy, economics, and social science.

"My favorite talk was the keynote address," said one attendee. "He made wind energy seem like a no-brainer."

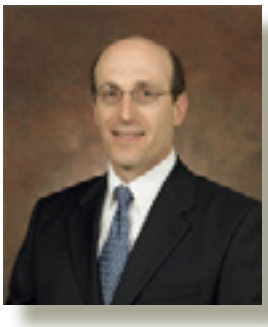
John Thackrah (BME1979), Deputy Assistant Secretary of the Navy for Management and Budget, called on his prior experience with United Technologies Corporation in the Pratt & Whitney and Otis Elevator divisions in delivering his talk on what it takes to be successful in the twenty-first century workplace.

"Twenty-first century engineering graduates find themselves in a very different world than just 20 to 30 years ago when considering a career path or further education," he said. "The post-9/11 world we live in is filled with higher risks and, at the same time, the opportunity for higher reward. One fact remains constant—the United States is losing its edge in science and engineering. Today's graduating engineer has a great opportunity to contribute to our nation's competitiveness."

Thackrah has developed an acronym, "CRISP," to represent five traits that are fundamental to success: Commitment, Results, Investment, Sweat the details, and Personal performance and perception. "These things mean more today than ever," he said.

Thackrah's talk was well received. "He delivered a message that every engineering undergrad needs to hear," said one alum. Another commented, "John Thackrah's talk on C.R.I.S.P. would benefit all students, so it would be a good introductory or closing talk."

Gary Hecht (BME1980), a partner in the law firm of Synnestvedt & Lechner LLP in Philadelphia, PA, spoke on "Patent Law: Innovation, the Process, and a Student's Perspective. Hecht has been practicing law for 16 years.



Hecht began by pointing out that promotion of innovation in our country goes back to the Constitution. Patents, which are a way of protecting innovators' rights to the products that they have invented, fall into three categories: utility patents, design patents, and plant patents. Key requirements are that the invention must be novel and not obvious.

Hecht reviewed the parts of a utility patent, with one of the most famous examples being the telegraph. He also presented some case studies to get the audience to think about whether an invention was patentable.

Finally, Hecht described patent law as a career. Patent attorneys, he said, must have a science or engineering degree (or enough credits in one of these fields to sit for the bar exam), as well as a law degree. He gave examples of what patent attorneys do and outlined other desirable traits.

"It's good to have good writing skills, good grades as an undergraduate, and good nerves," he said. "It's also good to be creative and detail oriented."

Jody Kuchler Morgan (BME1985), President of SPI Polyols, Inc., brought a sense of reality to the subject of starting a business. While there are lots of good ideas, she pointed out that 50% of small businesses fail in the first five years. "Most are started by equally enthusiastic entrepreneurs," she said. "What will make you different?"

Failures result from insufficient capital, poor inventory management, low sales, poor credit arrangements, lack of experience, and a host of other problems. These can be overcome, however, through thorough preparation and planning, business insight, a willingness to work hard, and a bit of luck.

Morgan compared the pros and cons of starting a new business versus buying an existing business or a franchise. She then provided an overview of the various steps involved in evaluating a prospect, determining a price, and developing a strategic plan.

With the business launched, Morgan said, "Remember—obtaining your goal will take teamwork, problem solving, and critical thinking. Don't go it alone. There are people, organizations, and information available to help."

"Most importantly," she concluded, "Have fun! You are going to spend a significant amount of your time working on your business. Learn, grow, enjoy. It's all part of the journey."

"I wish a seminar on this topic was offered during my UD years," said Tom Frey (BME1984, MME1990).

The fourth ME conference has been scheduled for April 28, 2008.

"We really hope to continue the trend of increased attendance next year," said Cloud, "with strong representation from all groups, including students, faculty, and alumni."

Robots Help Stroke Patients Regain Mobility

For stroke and spinal-cord injury patients, regaining the ability to walk can seem like an unreachable goal. But robotic devices being developed in the UD-ME Mechanical Systems Laboratory may bring this dream closer to reality for some patients.

A research group led by Professor Sunil K. Agrawal is developing a variety of exoskeletons for gait assistance and training of the movement impaired. The current group includes ME doctoral students Sai K. Banala and Vivek Sangwan, as well as Prof. John Scholz and members of his group from UD's Department of Physical Therapy (PT).

The research is funded primarily by the National Institutes of Health through a Bioengineering Partnership Grant and by the National Institute on Disability and Rehabilitation Research through a grant to a team led by the Rehabilitation Institute of Chicago.

Over the past five years, the work has resulted in the development of three lower-extremity exoskeletons for neuro-motor training. The first is known as a gravity balancing orthosis, or GBO, while the other two are referred to by the nicknames ALEX (actively driven leg exoskeleton) and SUE (swing-assist un-motorized exoskeleton).

"Each device has a unique design principle targeted for a specific population group, while addressing the issue of providing a flexible motor-learning environment," Agrawal says. "All three of them are designed for use on a treadmill equipped with a video monitor to provide the user with visual feedback on his or her gait motion through sensors on the exoskeletons."

GBO is an un-motorized exoskeleton that can alter the level of gravity at the knee and hip joints during motion. Agrawal explains that gravity plays an important role in human movement by assisting, or resisting, the motion of a joint such as the hip or knee over different parts of the leg swing. With an orthosis that alters gravity at the joints, the joints can swing through a larger range of motion for the same human-applied joint forces.

"As a result," says Agrawal, "this device enables a person with a weak musculature or poor motor control to gradually improve his or her gait and strength as the percentage of gravity assistance is reduced during training. And the GBO is tunable to the geometry and inertia of a specific human subject to achieve the desired level of gravity balancing."

So far, the device has been tested on healthy control subjects as well as on stroke patients with hemiparesis—partial paralysis affecting one side of the body, which is a typical result of stroke. The data show improved range of motion for the stroke patients with the use of GBO, but the most striking results were obtained with a chronic stroke patient who volunteered for training to determine the long-term training effects of the device. Agrawal explains that the term chronic as applied to stroke patients generally refers to those who are past the critical window of time when the brain can be retrained to restore lost functionality.

Surprisingly, it was found that this patient not only improved during training but actually continued to improve after the training regimen was over. "The improvement was reflected in all aspects of his performance," Agrawal says, including gait symmetry, speed, weight bearing, and range of motion."

"This suggests that his brain had been triggered and that the effects of the training were still ongoing even though he was no longer using the machine. Although these results were obtained with just one subject, we are very encouraged by this outcome."

In contrast to GBO, which is passive, ALEX features motors at the hip and knee to supplement what the human subject can't do to execute a certain gait pattern. With this device, the desired trajectory of the foot during walking is defined by a tube. The controller guides the foot back into the tube if it deviates outside. So far, ALEX has been tested only on healthy subjects, but it has demonstrated success in training them to walk differently from their natural gait through selective control. One remarkable result found was that in about 45 minutes of training with ALEX, a healthy person can be taught to walk in a significantly altered gait.

ALEX is now being tested with a larger sample of subjects. "What we're learning," says Agrawal, "is that there is a fair amount of plasticity in the human brain that enables it to be trained with a force-field environment. We believe that there is great potential for gait retraining using these robotic tools, but what we've learned so far is on healthy subjects. We won't know about the effects of these exoskeletons on stroke victims until we try these."

The third device, SUE, is designed for use with victims of spinal cord injuries, where the problem is weak musculature that prevents the legs from swinging correctly. In contrast to GBO and ALEX, SUE is not attached to a walker. The device, which is un-motorized, lightweight, and portable, exploits the propulsive force of springs at the hip and knee to aid the patient.

"The idea here is to harness the energy from the treadmill to help swing the legs," Agrawal says. "The movement charges the springs, and the energy is then released to propel the patient forward." SUE has been tested on a single healthy subject to show how the springs can be tuned to the needs of the individual patient.

"We believe that devices like GBO and ALEX can make a substantial difference in future gait training of patients suffering from stroke, while exoskeletons such as SUE and ALEX can impact training of spinal cord injury patients," Agrawal says. "Rehabilitation using such devices reduces the number of rehab personnel needed, and repetitive and task-specific gait training can be provided more easily than with conventional therapies. The visual feedback provided by the monitor also engages the patient more actively in his or her recovery."

For Agrawal, there is almost no limit to the potential of robotic assistance for disabilities. His research group has built novel designs for ankle orthoses and neutrally balanced "sit-to-stand devices" that can be used to assist and train the elderly in getting up from a chair. He is currently investigating new designs for upper-arm exoskeletons. "Biomedical robotics is evolving to be a major theme for our lab," he says.

General Motors VP Speaks at Delaware

Editor's Note: The following article was adapted and condensed from an article by Martin Mbugua that appeared in UDaily *on April 19, 2007.*

The ME Department hosted Larry Burns, VP of R&D and Strategic Planning at General Motors, on April 13, 2007. "Larry Burns is a strong believer in fuel cell technology," said ME Prof. Ajay Prasad, "and we were really pleased to hear him praise our fuel cell bus effort during his talk. It's not often that the VP of a $200 billion company comes to campus."

In introducing Burns, Prasad said, "I first got to know about Larry from a show on PBS called Scientific American Frontiers, hosted by Alan Alda. This particular episode was called 'Future Car' and featured some of the current pioneers in the field of advanced automobile technologies. One of the people whom Alan Alda interviewed was Larry Burns, and I was impressed by his passion and his energy and his desire to transform automobile. And it is our good fortune that we have Larry in person here to talk about this topic. It is really an exciting opportunity for all of us."

Speaking to about 100 students and faculty, Burns said, "It is very, very nice to see that you have a hydrogen fuel cell bus running here on your campus. You need to be enormously proud of that fact. There are not many of those buses that exist in the world and to be able to experience this cutting-edge technology firsthand and, importantly, to have created the relationships that allows you to get this bus built and on your campus is something that you should be very proud of."

"We are in a situation where energy is at the heart of the future of the world," Burns pointed out, adding that demand for petroleum is expected to grow by 70 percent in the next 23 years. "If we have energy security concerns today, imagine what those concerns are going to be in the year 2030. If you are in the auto business, where we are 98 percent dependent on petroleum for our energy sources, imagine the business risk in not having solutions to these issues."

Burns holds a doctorate in civil engineering from the University of California at Berkeley. He also has a master's degree in engineering/public policy from the University of Michigan and a bachelor's degree in mechanical engineering from General Motors Institute (now Kettering University).

Fuel Cell Bus Unveiled

A fuel-cell-powered bus that is now part of the University of Delaware's campus-wide fleet was unveiled on April 9, 2007, at a press conference at the Bob Carpenter Center. The event was attended by close to 100 people, including U.S. Sen. Thomas R. Carper (D-Del.); U.S. Rep. Michael Castle (R-Del.); UD faculty, staff, and students; school children from the local community; and reporters from TV and print media in the region.

The bus is the tangible culmination of a demonstration project being carried out by a multidisciplinary team in the College of Engineering and led by Ajay Prasad, Professor of Mechanical Engineering. The team also includes Suresh Advani, George W. Laird Professor of Mechanical Engineering, and Ardeshir Faghri, Professor of Civil and Environmental Engineering. The project is supported by a $1.7 million grant from the U.S. Department of Transportation's Federal Transit Administration, matched by private financing from companies working in partnership with the University.

Senator Carper referred to the vehicle as the "Magic Bus," and both he and Congressman Castle acknowledged that while it is "just one little bus," it will go a long way toward educating the public about alternative energy sources and answering questions about implementation of new technologies.

"Engineering is all about reducing science to practice," said Dean Eric Kaler, who also spoke at the event. "Demonstration projects are critical to public acceptance of new technologies, and this bus is a perfect example of how our work on clean energy is being reduced to practice."

After a period of service on UD's Laird Campus, the bus will be turned over to the Delaware Transit Corporation for use with the larger community. "Every trip this bus takes will increase our knowledge base about fuel-cell technology," said Prasad.

According to Faghri, the program's long-term goal is for UD to be positioned at the forefront of research, development, and implementation of the state of the art in hydrogen-based fuel-cell transit buses.

Student Highlights

ME Doctoral Candidate Wins Laird Fellowship

Erik Koepf

Erik Koepf came away from the Laird Fellowship social event thinking that he probably wasn't going to win but that at least he had had a good time. "I really didn't have an agenda," he says. "I was just myself."

Apparently that was good enough for the Laird Selection Committee because Koepf was chosen for the prestigious $25,000 award, which comes with no strings attached. Established in honor of George W. Laird, the Fellowship is given annually to a graduate student in engineering "to encourage the recipient to become engaged in a broadening intellectual pursuit that may or may not be of direct application to the recipient's chosen field of study."

Like the 29 Laird Fellowship recipients who have preceded him, Koepf, a Ph.D. candidate in Mechanical Engineering, is a well-rounded student with a variety of outside interests ranging from Ultimate Frisbee, soccer, and kayaking to music, art, and world travel. He sky-dives, surfs, and runs marathons.

But what apparently caught the attention of the committee was Koepf's passion for environmental awareness, education, and outreach. He has already amassed an impressive amount of experience in this area, even though he is only 25 years old.

Koepf grew up in Half Moon Bay, California, a small coastal community south of San Francisco. The son of a commercial fisherman, Koepf worked the nets with his father during school breaks, and the two collaborated to launch the Fishing Families Project. "There are lots of issues and misconceptions about commercial fishermen," Koepf says, "and our goal was to spread the word that fishermen are 'real people' too." The program included organizing field trips and developing demonstrations for school children.

After earning his bachelor's degree in physics from Occidental College in 2004, Koepf accepted a position as a teacher at a boarding school in Japan, where he instituted a cross-cultural environmental awareness program that connected his students with their peers at schools in California and Maine.

Koepf has also worked in construction, including one project that involved the sustainable remodeling of a historic home in Maine owned by the CEO of an environmental nonprofit group with which Koepf was involved.

And, although his undergraduate degree is not in engineering, Koepf crafted an education for himself in this field by attending classes at various colleges and universities during the summer.

With all of those elements forming his personal background, it was not surprising that Koepf set his sights on a career in energy engineering. One of the schools where he took engineering courses in his travels was the University of New South Wales in Australia, an institution where UD Prof. Christiana Honsberg has strong affiliations. All of the stars lined up right for Koepf to come to Delaware—he expressed an interest in studying sustainable energy as a graduate student and was immediately directed to UD and the Solar Hydrogen IGERT Program that Honsberg directs.

Funded by the National Science Foundation, the IGERT (Integrative Graduate Education and Research Training) Program is aimed at training Ph.D. scientists and engineers with "the interdisciplinary background and the technical, professional, and personal skills needed to address the global questions of the future."

The multidisciplinary Solar Hydrogen IGERT Program at UD was a perfect fit for Koepf, and his Ph.D. research will focus on solar thermal hydrogen generation for fuel cell applications under Profs. Ajay Prasad and Suresh Advani.

An IGERT Fellowship will support Koepf's graduate education, but the Laird, he says, will "free him to pursue such ideas that might otherwise merely remain in the back of my mind and imagination."

For Erik Koepf, everything he has done so far in his life is "connected through common themes of understanding, cooperation, modeling and restructuring our energy use and its interrelationship with the atmosphere and the built and natural environment." The Laird Fellowship will undoubtedly allow him to pursue the aspects of that theme that aren't addressed in his classes and the research labs here at UD.

"Bridging the gap in understanding and education about sustainable, renewable energy sources and technologies and making connections—the personal, human connections necessary to truly impart a sufficient level of understanding—are almost more critical than the raw science of the matter itself," he says.

George W. Laird

Victory at Detroit (Sort of)

by Steve Timmons, Formula SAE Team Advisor

For the first time in the history of Formula SAE at University of Delaware, our team finished the Enduro, the climax of the five-day international competition held at the Ford Proving Grounds north of Detroit, Michigan. A team of eleven, including students, alumni and the advisor, made the 1300-mile round trip. A group of eight students drove nearly non-stop in a large rented box van containing the precious car, followed by a UD minivan. The journey to Auburn Hills took nearly eighteen hours to complete, since the navigator stipulated that no tolls were to be paid. This decision, luckily, was overturned for the ride home, which took the more-standard ten hours.

The competition comprises a design presentation, a cost report presentation, a technical inspection, a "tilt test" in which the car is tilted on its side at 45 degrees and must not leak fluids (or flip over!), a braking competition, an acceleration competition, a skid pad competition, an autocross competition, and finally an endurance-economy competition of approximately 45 minutes, covering two stints of eleven laps of a roughly one-mile course. None of the competitions can be undertaken until the technical inspection is completed. Last year, at the California competition, the UD team competed all events except the Enduro. Halfway through the event a lug nut was determined to be loose, and the team was disqualified. As a result, the securing mechanism was redesigned for this year's competition.

On Wednesday morning, we looked good. The presentations were given, and the car was prepped for competition. Technical inspections began on Thursday, and the students assumed this would be an easy trial because the car had passed at the previous competition. This proved to be an extremely poor assumption…. Tech, as it is called, can be difficult and unfortunately can also be up to the whim of the individual inspectors looking at the car.

Here's how it works: The car goes into an inspection area, and a group of judges closely examines the car looking for safety infractions, rules violations, things they would have done in some other way, etc. Essentially any "suggestion" they make must be implemented before the car passes tech. The car went through the first time with only minor issues—a few gaps in the bodywork around suspension members, some trim around the seat belts, small and relatively easy things to fix. The fixes must be made back in the team's pit, which is a 20-minute push from Tech.

So the car gets rejected, the fixes are made, and the car moves to the end of the line to await re-inspection, which takes a few hours, and time slips gently by. On the second round, since there is a different set of judges, a whole new set of "infractions" is found, and the process is repeated. It doesn't much matter that the first judges, or those at the previous competition missed them; they need to be fixed, and so goes the loop.

Now it was 2:30 PM Thursday. The braking, acceleration, and skid pad competitions closed at noon on Friday. Now for the fun part. One of the judges decided that the fuel filler neck was not constructed in accordance with the rules. The rules stipulated that the neck had to be at an angle of zero to 45 degrees from vertical. While our neck was at 15 degrees, it also curved to allow the cap to be mounted flush with the bodywork, at 90 degrees from horizontal. While the judges agreed that this was not a safety issue, they did insist that it be remedied, since the rules showed a straight tube.

The fuel tank is an aluminum fabrication with the filler neck welded on. It contains roughly 3 gallons of fuel (and was full), along with a foam insert to minimize sloshing, and is mounted under the driver's seat. After

an hour or so, it was removed and we took it to the Lincoln Welding booth, where free welding services are offered for consultation. We were told that it could be welded if we could find a new pipe for the filler neck and if the tank was filled with water to prevent explosion. We begged the required tubing from another team, cut up the tank and filler, and filled it with water, then waited in line for our turn with the welder. Carl from Lincoln Electric did a wonderful job, and the tank was good to go by 5 PM. Only one problem. It was full of water.

Despite protests from the advisor, the solution to the water problem was to let the tank dry out overnight. How the foam in the tank would magically release thousands of water droplets through the 1-inch filler neck was beyond comprehension, but that was the decision made by the team members, i.e., worry about it the next day. It was of little surprise the next day, when the fuel tank was installed and filled with gas, that the engine would not start. All the fuel lines were full of a murky water-gas mixture, and time was running out. The solution was to use the fuel pump to pump the remaining mixture out, fill the tank with fresh gas, then repeat this process until no more water appeared. This took until noon, so the first three competitions were forfeited.

Next was the Tilt-Test, which we passed after some application of duct tape. We barely got the car ready for the Autocross and finished mid-pack. Friday was over, and all that remained was the Enduro. Unfortunately, the differential was making some rather bad noises, the axles were somewhat loose, and a series of dents in the housing appeared during the Autocross indicating loose metal objects within! Nothing could be done, but we did realize that if the differential leaked fluid (as it had in the 2005 competition) we would be disqualified. As a result, the entire housing was wrapped in duct tape several layers thick, so that even if the internals let go, the leakage would be minimized.

So on to Saturday, and the Enduro. Amazingly, the car ran flawlessly, and 45 minutes later we had completed it, something only 36 of 106 entrants managed to accomplish. Overall we ranked 57 out of 106, which is better than any year previous.

For next year, an entirely new car will be constructed for what we are sure will be an entirely new adventure.

Honors Day Mechanical Engineering Award Recipients May 4, 2007

Senior Year Awards

W. Francis Lindell Mechanical Engineering Award to the Distinguished Senior

ANDREW SEAGRAVES
JOSHUA TREISNER
HADI FATTAH

Mary and George Nowinski Award for Excellence in Undergraduate Research

AARON WINN

Junior Year Awards

W. Francis Lindell Mechanical Engineering Award to the Distinguished Junior

MATTHEW JASKOT
RONALD CAPALBO
BENJAMINE BINDER-MACLEOD

W. Francis Lindell Mechanical Engineering Achievement Award

NICK HIRANNET
JESSICA DIBELKA
DANIEL GEMPESAW

Sophomore Year Awards

W.J. Renton Award for Outstanding Sophomore

THOMAS MINTEL

Other Department Awards

Delaware Section of The American Society of Mechanical Engineers Outstanding Student

JULIANNE TWOMEY

American Society of Mechanical Engineers Student Section

MARY C. WIONCEK

Robert T. Bosworth Scholarship

MICHAEL A. MORTON

Redden Scholarship

ROBERT T. LORT

J.L. Nowinski Annual Lecture

PROFESSOR HUAJIAN GAO

Newman Fund Scholarship

CHAD AGOSTINELLI

Alumni News

Tom Aukzemas (BME1991) and his wife, Barbara (Hymowitz) Aukzemas (BA 1992), spent the summer of 2006 in Shenzhen, China. Tom is a Senior Design Engineer for Southco in Concordville, PA, and was on assignment working for his company. They are expecting their first child at the end of August 2007.

David Hutton (BMAE1967) has retired after 38 years in various engineering and marketing management positions with Baltimore Aircoil Company. He has established a consulting business, Delta-H Systems, LLC, to pursue consulting opportunities in heat transfer and thermodynamic applications for industrial equipment (you MEs out there will appreciate the significance of the business name).

Dave and Susan Deppert Hutton (BSHE1967) will celebrate their 40th wedding anniversary later this year and have two grown children. Dave and Susan reside in Baltimore, MD, and St. Michaels, MD.

Angela (Miller) Schweitzer (BME1994) had a son, Mathias Joseph Schweitzer, on December 30, 2006. Schweitzer is a Group Engineer at The Lee Company in Westbrook, CT, where she has been working for 11 years. The Lee Company manufactures flow controls for the aerospace, downhole oil tool, formula one racing, and medical industries.

On January 4, 2007, **Jack N. Pezza** (BME1998) and his wife Marylou celebrated the birth of a healthy and beautiful baby girl, Brianna Nicole Pezza.

Eric D. Ramos

Eric Dayrit Ramos, age 34, died Friday, May 18, 2007 from injuries sustained in an auto accident in Tannersville, PA. Ramos graduated from UD in 1997 with honors and completed an undergraduate thesis with former ME professor Tony Wexler. He then earned a master's degree in 1999 under the advisorship of Prof. Tom Buchanan. His thesis was entitled "Dynamic Stability in the Anterior Cruciate Ligament Injured Knee: Motion Analysis Using a Perturbation Device."

"Eric was a great member of the lab," Buchanan recalls, "and his enthusiasm for his work and his love of life will be missed."

Ramos was a Lead Commissioning and Qualification Engineer with the Jacobs Engineering Group in New Jersey at the time of his death. Eric had joined Jacobs Applied Technologies in 2003. In 1999, he had started as Validation Engineer for Millennium Validations.

Born in Davao City, Philippines, Eric was the son of Felicissimo Sr. and Amelita Dayrit Ramos. He is survived by his wife Beatrice Frask-Ramos, and their daughter Ellyse Hyacinth Ramos, 28 months old; two sisters and a brother; and several aunts and uncles. Originally from Newark, Del., Ramos will be buried in the All Saints Cemetery at 6001 Kirkwood Highway, Wilmington, Del.

Alums Honored at Spring Conference

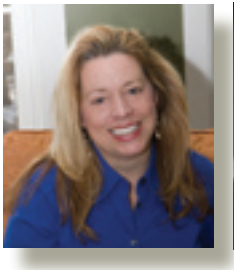
Six distinguished alumni were honored at the Mechanical Engineering Business, Technology, and Career Conference, held on April 27, 2007. Alumni are selected for recognition based on several criteria, including achievement, impact, uniqueness, and interest. The following are this year's Distinguished Career Alumni (DCA).

Donald R. Cohee PE (BME1968)

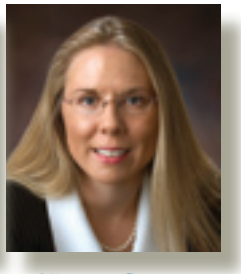
James B. Foulk (BME1959)

Michael J. Doyle (BME1992)

Jerry Kegelman (BME1978)



Jodie (Kuchler) Morgan (BME1985)



Nancy Sottos (BME86 and PhD91)

Alum Works on Fuel-Cell Bus Project

Even though he graduated just a year ago, Research Associate Doug Brunner (BME2006) is already making a significant contribution to a major research and demonstration project at the University of Delaware. The ME staff member spent the first eight months of his University employment in Los Angeles, where UD's first fuel-cell bus was undergoing construction and initial testing by EBus, Inc.

"I was sent there to work with their engineers and scientist to fabricate the bus and instrument it with a variety of sensors so that we can monitor the efficiency, reliability, and durability of the bus," Brunner says. The instruments include flow meters and humidity sensors as well as a voltage monitoring system.

The bus, now part of UD's campus-wide fleet, is part of a research and demonstration project being carried out by a multidisciplinary team at UD. ME faculty members Ajay Prasad and Suresh Advani are investigating fuel-cell technology, while Ardeshir Faghri, Professor of Civil and Environmental Engineering, is involved in the transit aspects of the project (see related article on page 12).

Brunner is well suited for the fuel-cell bus project. He has not only a degree in mechanical engineering but also experience in electronics, which he gained doing projects for himself and working on UD's Formula SAE race car. Brunner actually designed the circuits for the voltage monitoring system, which monitors the voltage in each cell.

"We want to figure out how long the cells will last in actual service," Brunner explains. "Ballard achieved 10,000 hours in the lab, but we know that the actual service life will be much less, maybe one to two thousand hours."

Although the bus is now servicing the University's Laird Campus, it is still a work in progress. The cells are sensitive to cold, and the system sustained some freeze damage during the trip to Delaware. This resulted in challenges with getting it to full power, according to Brunner.

He is currently waiting for delivery of a mechanical hydrogen pressure regulator to replace the electronic one currently in use. "The new regulator should provide us with better matching of pressure, which should extend the stack life," says Brunner.

Although Brunner realizes that an ME career in the private sector would probably have been more lucrative for him, he is quite satisfied with where he is. "I have the freedom to take initiative on things," he says, "and I'm working in a very interesting field."

This summer, he will also have the opportunity to mentor an undergraduate researcher. Under Brunner's supervision, ME junior Shawn Nicholson (BME2008) will investigate control of air pressure in the fuel-cell system.

"Doug came up with many design changes to improve the fuel cell and bus performance," says Advani. "This project would not be as successful as it is without his involvement."

Feedback Form

Do you have any feedback (comments, questions)? Or let us know any current events or info not covered by the data sheet below.

Information form for the department's records

Name _____
First Middle Last Maiden

Delaware Degree BME Date_____ MME Date_____ Ph.D. Date _____

Spouse's Name_____ DE Alum? _____

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Company Your Position

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Return this form to: Nate Cloud, 126 Spencer Lab, University of Delaware, Newark DE 19716 and/or contact me at cloud@me.udel.edu or 302-737-4111

We wish to thank the many ME 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 fill out the form below and return it with your check made payable to the University of Delaware. If you want your donation to go to the Department of Mechanical Engineering, please indicate that on the form and in the memo line on your check.

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