Greetings from the Chair

Welcome to mechanical engineering’s fall newsletter 2009. The past year has been an exciting one for our department with several new faculty, significant external honors and awards, additions to our external advisory board, high student achievements, and record success in funded research. While two of our new faculty here highlighted in the previous newsletter, in this issue we introduce Todd Murphy, who applies theory, simulation and experiment in control of complex mechanical systems to various robotic devices and even marionettes to help understand optimal motion for rehabilitation. This past year we also welcomed four new members to our outstanding external advisory board: Ben Freund (NU alum 1997 and currently professor at Brown University), Julio Santos Munro (ME alum 1986 and currently Director of Operations at Kinea Design), Bob Shaw (ME alum 1970 and former VP and co-owner of Milpex Products), and Tony Swaner (ME alum, 2004, 2006 and currently consultant for Ernst and Young). They join a small and active board with increasing involvement in the department. We thank all our board members for the donation of their time and energy and ideas to help move the department forward. With unique funding opportunities from the federal agencies, our faculty responded by submitting a record number of exciting proposals for new research, and were incredibly successful, bringing in . . . (continued on reverse)

New Nanodiamond Tool for Next-Generation Cancer Treatments

Mechanical engineering professors Horacio Espinosa and Dean Ho are using nanodiamonds to develop innovative cancer treatments. The research group has created a tool called the Nanofountain Probe to precisely control nanodiamond placement in two ways. In the first mode, the Nanofountain Probe acts like a fountain pen using an “ink” of nanodiamonds in solution. In the second mode, the probe is able to inject nano-diamonds directly into single cells. Their results were recently published online in the scientific journal Small.

The Nanofountain Probe has been used to create a pattern of dot arrays of drug-coated nanodiamonds on glass substrates with a resolution better than 100nm, three orders of magnitude finer than previously achievable. These arrays demonstrate the ability of the probe to be used in the manufacture of implantable drug delivery devices.

The device may also be able to be used to refine another drug delivery scheme developed by Ho and colleagues: a polymer patch that could be used to deliver chemotherapy drugs locally to sites where cancerous tumors have been removed. This patch is embedded with a layer of drug-coated nanodiamonds, which moderate the release of the drug. The patch is capable of controlled and sustained low levels of release over a period of months, reducing the need for chemotherapy following the removal of a tumor. (continued on reverse)
Greetings from the Chair
(continued from front page)

...significant new awards which will grow our output in PhD students, papers and awards in the coming years. Additionally, three of our young faculty have received prestigious NSF CAREER awards this past year.

Our undergraduate student population continues to increase, with the constant importance of the field of mechanical engineering to both applied industrial design and fundamental research in areas from those traditionally considered ME (e.g., robotics) to highly interdisciplinary studies (e.g., see nanodiamonds article). New faculty member Liz Gerber (profiled in the last issue) started a new initiative for undergraduate engineers called Design for America, which has enjoyed tremendous success and popularity locally and is sparking groups nationally. A new applied MS program has been started, offering current undergraduates seamless BS/MS options and attracting students from other undergraduate disciplines and institutions. A mini-MBA minor as part of the MS program has proven attractive for many students. We will highlight some of these initiatives in coming newsletters.

Enjoy our newsletters and feel free to contact me with any comments or questions about the department.

STEP Program
(SWE Summer Program for Girls)

This past summer, girls going into 8th and 9th grades participated in a program put on by Northwestern University chapter of Society of Women Engineers called the Summer Technology and Engineering Program (STEP). The three-day program, coordinated by ME senior Jessica Swenson, was designed to encourage them to consider careers in engineering. Other counselors included ME undergraduate Regan Radcliffe, and ME graduate student, Tiffany Davis. ME lab instructor, Michael Beltran, demonstrated the plastic injection molding and a three-axis milling machine. The group also visited the UMed lab and were shown the T-Pad devices by graduate students Dan Johnson and Eric Chubb.

This year, the program theme was sustainability. Participants toured a green roof, created green roof mock-ups of their own, built solar powered robots, and heard from professional engineers. "Right now, as they are going into high school, we are planting that seed hoping they realize their potential, how great it is to be an engineer, and what they can do with an engineering degree," says Jessica Swenson, coordinator of the program. A video about the STEP program can be seen online at http://www.mccormick.northwestern.edu/news/articles/547

Multi-Million Dollar Research Grant

Professor Horacio Espinosa and his collaborators will receive up to $7.5 million from the U.S. Army Research Office for the study of disruptive fibers. The grant was part of $250 million recently awarded by the Department of Defense as part of the Multidisciplinary University Research Initiative (MURI) program, which supports research by teams of investigators that intersect more than one traditional science and engineering discipline to accelerate both research progress and translation of research results to application.

Next-generation defense systems, like flexible armor, require lightweight advanced fibers like those Espinosa and his collaborators hope to develop. Disruptive fibers could also be used to make vests for soldiers, textiles for parachutes, or...
Robots Battle in Design Competition

At the 18th annual Undergraduate Design Competition in May, 12 autonomous robots battled in three-way matches while up to 100 participants and spectators looked on. Each robot had a designated area and color, and teams attempted to get balls of their own color out of the arena (+3 points per ball of their color out of the arena) while preventing balls from remaining in their designated area (-5 points per ball remaining in their area).

The top three teams earned cash prizes of $3,000, $2,000, and $1,000, donated by industry sponsors including Ford Motor Company, DMC Engineering, Northrop Grumman, Delphi, and Kinea Design. Also awarded was the Myke Minibot elegant engineering award in memory of a McCormick alumnus and 2001 winner of the design competition, who was killed in a 2007 hit-and-run. The Minibot winner was eliminated in the semi-finals, but dazzled the crowd with four columns of spinning lights.

Forty-five undergraduates from mechanical engineering as well as other engineering fields spent six months designing, building, and programming their robots, which used lasers to detect the balls and many different methods to get and throw the balls by using arms, scoops, and vacuums. The robots could not be directed with remote control, but the teams were allowed to reprogram robots as often as desired.

Professor Michael Peshkin received a 2008 Murphy award to improve the Design Competition and update fundamental electronics and programming education in the McCormick School of Engineering, and the results of his efforts were evident. Corporate sponsor representative and former competitor, Judy Kopie, noted that this year's competition showed a "level of competition, enthusiasm, and spectator interest...that was simply amazing."

A video of this year's winning teams can be seen at http://www.mee.cornell.edu/191/143.

Grants Awarded to ME Professors

Composite material used in vehicles, airplanes, and satellites.

These fibers could provide superior protection against blasts and other impulsive loads such as those generated by foreign object impact.

Professors Chang Liu and Mitra Hartmann in collaboration with Professor Doug Jones at the University of Illinois Urbana-Champaign and Professor Alan Kadish from Northwestern's Feinberg School of Medicine received a $2 million grant from the National Science Foundation's Office of Emerging Frontiers in Research and Innovation. The office awarded the highly competitive grants for "transformative ideas that represent an opportunity for a significant shift in fundamental engineering knowledge with a strong potential for long-term impact on national needs or a grand challenge."

The researchers seek to develop a flexible, sensing skin that can discern contact and temperature using biologically inspired principles. One application may lie in creating catheter tips for cardiac surgery procedures to increase accuracy, reliability, and speed.
New Nanodiamond Tool for Next-Generation Cancer Treatments

(continued from front page)

"An attractive enhancement will be to use the Nanofountain Probe to replace the continuous drug-nanodiamond films currently used in these devices with patterned arrays composed of multiple drugs," Ho says. "This allows high-fidelity spatial tuning of dosing in intelligent devices for comprehensive treatment."

The probe can also be used as a single-cell syringe, permitting direct injection of nanodiamond into individual cells. This provides both the advantages of the ability of nanodiamonds to slowly and steadily release drugs that have been attached to them along with the precise delivery of the drugs.

Ho recently received the Wallace H. Coulter Foundation Early Career Award for Translational Research. The award allows Ho to explore the application of devices that combine nanodiamond clusters and nanoscale polymer films to treat complications (e.g., inflammation and scarring) associated with open heart surgery.

"Nanotechnology is changing the face of drug treatment strategies," Ho says. "We hope our research will inspire new applications for nanomedicine that stand at the forefront of biology and engineering."

Pictured above: A fluorescence microscopy image showing a single cell injected with a fluorescent marker using the Nanofountain Probe. The Nanofountain Probe enables researchers to target individual cells within a large population and even specific regions of individual cells. This technique enables single cell in vivo delivery of a variety of therapeutically relevant agents.

Professor Todd Murphy Joins the Department

Todd D. Murphy received a PhD in control and dynamical systems from the California Institute of Technology in 2002. He was an Assistant Professor with the Department of Electrical and Computer Engineering at the University of Colorado at Boulder from 2004-2008 and joined Northwestern University's mechanical engineering department in 2009. He is a recipient of a National Science Foundation CAREER award and is an associate editor of the IEEE Transactions on Robotics and the journal Roboica.

Professor Murphy's research interests include simulation of mechanical systems, the role of uncertainty in robotics systems, hybrid optimization for nonlinear systems, and planning for friction-dominated mechanical systems. In particular, he is interested in computational methods for simulation and control of complex mechanical systems; he uses model-free as testbed examples of complicated systems that are beyond the scope of traditional embedded control methods. Practical applications of the resulting techniques include control of prosthetic devices.
Selected Mechanical Engineering Awards Fall 2009

Faculty

Jan Achenbach was selected as the first recipient of the Mindlin Medal of the American Society of Civil Engineers.

Jian Gao was elected to be the secretary of the SME North American Manufacturing Research Institute.

Wei Chen was elected a fellow of the American Society of Mechanical Engineers (ASME) and was elected to executive committee of the ASME Design Division.

Liz Gerber and Todd Murphey were selected as Searle Faculty Fellows.

Liz Gerber, Todd Murphey and Ann McKenna were selected to take part in the National Academy of Engineering’s (NAE) first Frontiers of Engineering Education (FOEE) symposium.

Walter Herbst was selected as Faculty of the Year for the MPD program.

Yonggang Huang was awarded an honorary professorship from the Nanjing University of Posts and Telecommunications, China.

Leon Keer was selected as the recipient of the Mayo D. Hersey Award from ASME and received the award at the ASME/STLE joint tribology conference in October.

Malcolm MacIver received an NSF CAREER award.

Ann McKenna was selected to serve as a 2009-10 program director in the Undergraduate Engineering Education division at NSF.

Neelosh Patankar was selected by the undergraduate student body as one of the seventy members of the 2009-2010 Faculty & Administrator Honor Roll.

Students

Jennifer Berger, Nathan Henry, Mark Straccia, and Matt Turpin, four ME seniors, were awarded second place in the 2009 Margaret and Mulk Frey Memorial Prize for their project: “Robotic End-Effectors for Automation of Sliced Meat Packaging.” The prize was $8,000 to the students and $3,000 to the faculty adviser, Professor Wei Chen.

Robert Gracio was awarded the Melosh Medal for his work with Ted Belytschko on continuum-atomistic modeling of dislocations.

Aaron Greco was awarded the Christine Mirzayan Science & Technology Policy Graduate Fellowship Program of the National Academies for an internship on the Board of Energy and Environmental Systems and was also awarded the IGERT Trainee Poster Challenge Award for Communications Excellence.

Lin He was awarded a 2009 Altair Fellowship.

Allison L. Juster was one of the 10 students chosen as the first class of the Initiative for Sustainability and Energy at Northwestern’s cluster fellows program.

Aaron Greco and director of the IGERT program, Holly Green.
Students Win Second Place in Memorial Prize

A group of Mechanical Engineering seniors took second place for the 2009 Margaret and Mur Frey Memorial Prize awarded for the best innovative or creative-integrative "capstone" project as judged by a jury of recognized leaders from the fields of engineering. The project, "Robotic End-Effector for Automation of Sliced Meat Packaging" was designed by Jennifer Breger, Nathan Hensy, Mark Stracolias, and Matt Turpin, and won $8,000 for the students and $5,000 to the faculty adviser, ME professor Wei Chen.

This project came out of the idea that the industry standard for packaging sliced meat — hiring workers to pick up stacks of meat from the end of a conveyor belt and placing them into packages — just wasn't cutting it. The process is inefficient, unhealthy, and tedious, the students said, so they developed an innovative robotic system to pick up the stacks of meat and place them into the package. This was no easy feat; previous incarnations of a similar device in industry damaged the meat and placed it incorrectly in the storage pack. The group's device eliminates sliding contact with the meat. According to their client, "This design is important in applying robotics in order to increase food safety and improve production volumes and reliability."

McCormick
Department of Mechanical Engineering
Robert R. McCormick School of Engineering and Applied Sciences
Northwestern University
Technological Institute
2145 Sheridan Road
Evanston, Illinois 60208-3100

Nonprofit Organization
U.S. Postage
PAID
Northwestern University