IOWA STATE UNIVERSITY
COLLEGE OF ENGINEERING
ME UPDATE
Fall 2005 Newsletter Volume 15 Issue 1

ME expertise applied to health issues

The human body is an incredible machine. Thousands of parts work in concert 24/7 to perform countless functions that keep it working. Like any other machine, however, the human body has parts that deteriorate and wear out.

That's where biomedical engineering enters the picture. Broadly defined as the application of engineering principles and techniques to solve medical problems, the field has grown immensely in recent years.

In *The Engineer of 2020*, the National Academy of Engineering forecasts continued growth in the biomedical engineering field. Collaborations between engineers and life sciences professionals have led to the continued development of new technologies. These technologies have brought a better understanding of physiology, biology, and chemistry, leading to many advances in the treatment of health problems. But it is a progressive cycle, with more knowledge to gain and improvements to be made.

Joint replacements

Nearly everyone knows someone who has had a hip or a knee joint replaced. The Center for Disease Control and Prevention projects the trend for joint replacements to continue increasing from 500,000 in 2000 to 2,000,000 in 2030. ME researchers at Iowa State are looking at ways to increase the long-term success of these replacements.

ME Assistant Professors **Sriram Sundararajan** and **Pranav Shrotriya** are working to understand artificial joint wear in order to determine what materials will make the replacements more durable. Sundararajan is applying his expertise in tribology to find an optimal surface roughness that will minimize the generation of wear particles. He's also studying how the interaction between the protein components of body fluids and polyethylene, a material commonly used in joints, affects friction and wear behavior. Using experimental techniques that can study the interaction of two surfaces at various scales, from nano- up to microscale, Sundararajan is evaluating what happens at the interface of the two materials.

PhD student Cris Schwartz built a machine that simulates the motion of hip or knee joints to learn more about the mechanical properties of cartilage. The goal is to help researchers develop better materials for artificial joints.

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Alumnus wins PECASE

Martin L. Culpepper (BSME—ISU; PhDME—MIT) admits he still likes to build big machines, but it's nanomanufacturing—building very, very small machines out of individual molecules—that has his focus now. And it's gotten the attention of other people.

In June, Culpepper, the Rockwell International Assistant Professor of Mechanical Engineering at MIT and a 1995 ME alum of Iowa State, received the Presidential Early Career Award for Scientists and Engineers (PECASE). Presented in a ceremony at the White House in June, PECASE is the highest honor for young professionals who have shown exceptional leadership potential at the frontiers of scientific knowledge.

Today, just 10 years after graduating from Iowa State, Culpepper is recognized as one of the leading young researchers in nanoscale positioning and manipulation.

"I think we'll be some of the first people to build really complex small-scale machines like small robots that can move around," he says of his research group. "We've done the design work, and now we have to demonstrate it works."

In August, Culpepper and **Judy Vance**, ME professor and chair, received National Science Foundation funding for a collaborative three-year research project to look at ways to improve the design and manufacturing of compliant mechanisms, a class of mechanism used in nanotechnology, through the use of virtual reality.

INSIDE THIS ISSUE:

Two winners—Pate and Castleberry

A good product is said to sell itself. That seems to be the case with Professor **Michael Pate's** classes. Recipient of the 2005 college Superior Engineering Teacher Award, Pate has created two undergraduate elective courses since 2002. ME 433, Alternative Energy Conversion, which focuses on technologies that could potentially reduce dependence on fossil fuels, and ME 443, Compressed Air Systems, which concentrates on the most common method for operating industrial machinery and equipment, are the two most popular ME courses, with enrollment increasing each semester.

It's not because they're easy—intense homework is routine. One student wrote: "Dr. Pate's unique teaching style enables students to work harder and learn more than they do in many other classes." How better to describe an outstanding teacher?

The 2005 recipient of the college Superior Engineering Advisor Award is **Paul Castleberry**. Although he's only been advising ME students for four years, Castleberry is already well known for his commitment to helping students achieve their goals. He developed a Web-based tool called the Graduation Planner, which has assisted both ME students and faculty. The planner empowers students by giving them access to the information they need to plan their academic careers. In addition, the tool gives advisors more time to discuss leadership opportunities, scholarships, study abroad opportunities, internships, and co-ops, as well as graduate and professional programs, with their advisees.

Castleberry was praised for his professionalism, his encouragement, and his "can-do" attitude in helping students.

2005 ASME Dedicated Service Award

Associate Dean **Ted Okiishi** received a 2005 American Society of Mechanical Engineers (ASME) Dedicated Service Award in recognition of his years of voluntary service to ASME and its International Gas Turbine Institute (IGTI).

An ASME Fellow, Okiishi received the Melville Medal for best current original paper in both 1989 and 1998 and has been technical editor of the *Journal of Turbomachinery* since 1993. He's also active in the American Society for Engineering Education, serving as vice president of Institutional Councils and as chair of the Engineering Research Council. A member of the Iowa State faculty since 1967, Okiishi served five years as ME chair prior to his appointment as associate dean in 1995.

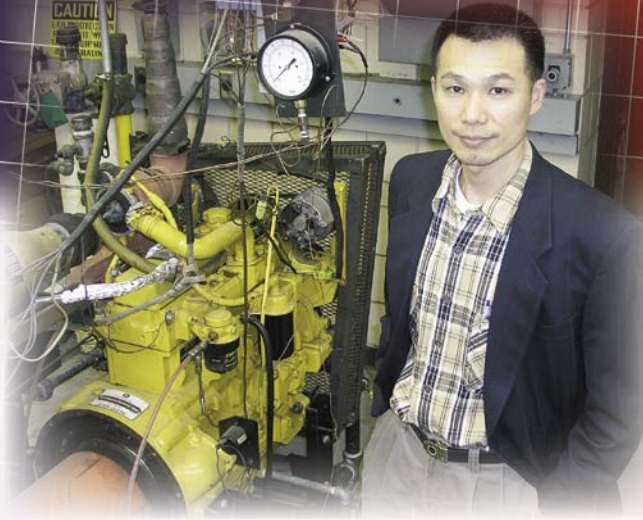
Spring ME classes offered via EDE

A wide selection of ME courses are offered through Engineering Distance Education for degree and non-degree students. New classes start January 9, 2006 with registrations accepted through December 30, 2005. Spring courses include:

ME 425 Mechanical System Optimization
ME 451 Engineering Acoustics
ME 484X/584X Technology, Globalization, and Culture
ME 511 Advanced Control Design
ME 516 Kinematic Analysis and Synthesis of Mechanisms
ME 527 Mechanics of Machining and Finishing Processes
ME 528 Micro/Nanomanufacturing
ME 536 Advanced Heat Transfer
ME 542 Advanced Combustion
ME 563X Micro and Nano-scale Mechanics
ME 578 Nonlinear Systems
ME 625 Surface Modeling

Complete course information is available at 800-854-1675 or www.ede.iastate.edu

Kong aims for the max in engines



With gas prices skyrocketing this fall, **Song-Charng Kong** should have no trouble promoting his research. ME's newest assistant professor is an engine combustion researcher working to make engines more efficient and to reduce their emissions.

Kong earned his BS in ME at National Tsing-Hua University in 1987 and his PhD from the University of Wisconsin–Madison (UW) in 1994. His research into internal combustion engines began as a graduate student at UW. "I was interested in combustion chemistry, and my advisor was doing engine research," he explains. "I realized the engine is the most important combustion system in transportation, and it uses the most energy."

During the past seven years while working as a research scientist at the Engine Research Center at UW, Kong has developed computer models to simulate engine combustion.

"We run a computer code that lets us see the details of what the engine is doing," he explains. "While we keep improving the accuracy of the models, we also developed an optimization technique, which is a fast and efficient way to determine how to get maximum performance out of an engine. Otherwise, you have to run an engine in a lab for days or months at a time and use trial and error to find out what works best."

Time is of the essence these days, though. New federal emission regulations, scheduled for implementation in 2010, are a driving force for manufacturers to come up with designs that satisfy new pollution standards. And it's not just the automotive industry that's affected. The new regulations cover everything from the small engines that power lawn mowers to the super size engines that move ships.

With his move to Ames, Kong plans to expand his research to study biodiesel fuel in diesel engines. Iowa State's prominent work in biorenewable resources was a key factor in his decision to come here.

"Biorenewable energy is becoming increasingly important in meeting U.S. energy needs," Kong says. "I'm eager to see how biodiesel fuels perform in the new diesel engines. I want to develop an optimization technique so we can maximize performance using them."

Kong, who taught at Chung-Hua University in his native Taiwan from 1994 to 1998 and later at UW, will share his expertise in the classroom too. His teaching assignments include internal combustion engines and engine design.

Kelkar named AMSE Fellow

Atul Kelkar, ME professor, has been named a Fellow of the American Society of Mechanical Engineers (ASME) International.Since 1996 when he received a National Science Foundation (NSF) CAREER Award, Kelkar has had continuous research support from NSF and NASA.

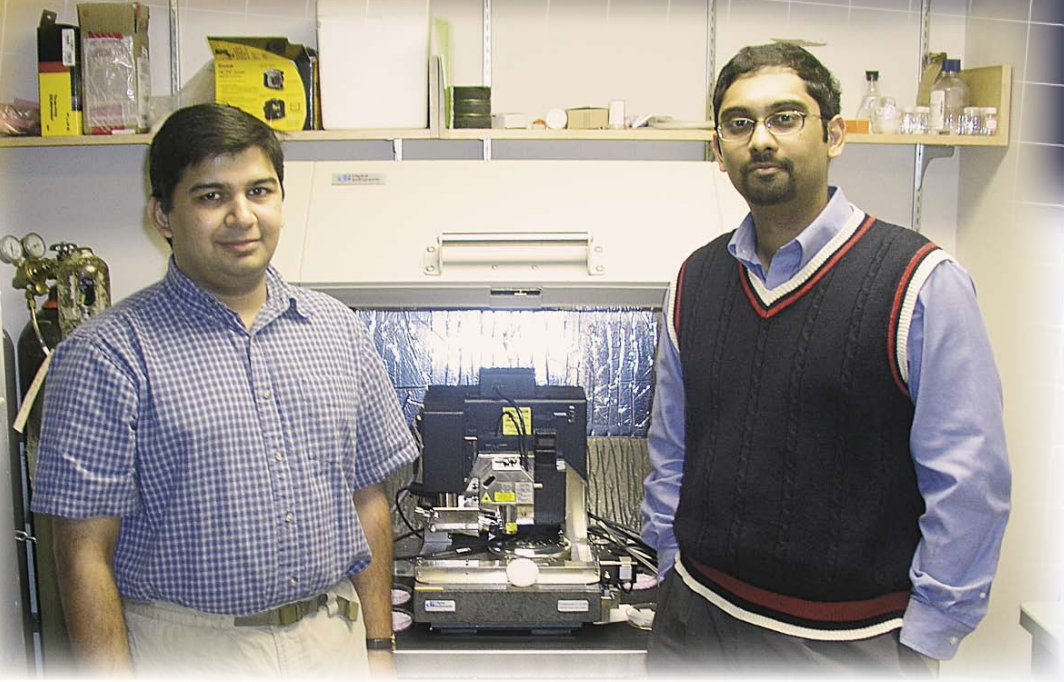
His novel approach to reducing noise led to his development of new technologies (patents-pending) for vibration and noise control. Kelkar initially focused on airplane noise, but now he's developing a "smart" material that will control noise and vibrations in a variety of environments. Work is being conducted at Vibroacoustics Solutions Inc., a start-up company he co-founded.

Kelkar's research also includes designing controllers for the next generation of aerospace structures. He recently completed work on the complex design requirements for the attitude and articulation control system in NASA's proposed Jupiter Icy Moons Orbiter. This nuclear-powered spacecraft must be capable of making the five–to–eight year trip to Jupiter and then orbit Jupiter's moons while conducting extensive investigation of the moons' chemical composition and their potential for sustaining life.

Vice provost is ME prof

John Brighton, Iowa State University's new vice provost for research, is also a professor in mechanical engineering. A Fellow of the American Society of Mechanical Engineers, Brighton was instrumental in creating the society's bioengineering division. An alumnus of Purdue University, he earned his undergraduate and graduate degrees in mechanical engineering, completing his PhD in 1963.

Brighton began his three-year appointment as vice provost at Iowa State on September 1. Formerly assistant director of the National Science Foundation and head of the Engineering Directorate there, he brings a wealth of leadership and research experience to Iowa State.



Sriram Sundararajan (right) and Pranav Shrotriya with the scanning probe microscope

Health issues continued from page 1

"We've found that surface roughness does affect friction and wear behavior, and as we expose the polymer to the protein solution, the friction actually increases," Sundararajan says. "That explains why there is resistance to motion, and that can help us understand other details of the wear process."

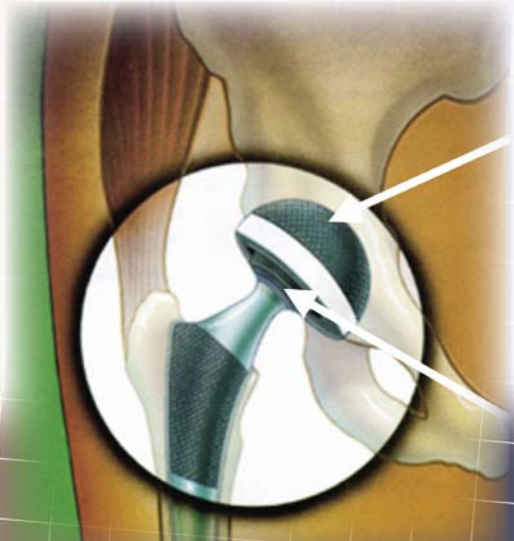
Shrotriya, meanwhile, is studying how surface roughness of certain metallic materials influences corrosion behavior. "Two metal surfaces rubbing together cause corrosion," he says. "That rate goes up exponentially when those surfaces are also in a corrosive medium at a high temperature."

Sundararajan and Shrotriya work with Michael Conzemius, an associate professor in veterinary medicine, to get insights into the biology side of the problem. They emphasize the interdisciplinary nature of their work and the importance of on-going dialogue with doctors and others in related areas.

While Shrotriya and Sundararajan continue to pursue funding through agencies such as the National Science Foundation and National Institutes of Health, they are also sharing what they learn with ME students. Shrotriya will talk about how chemistry and mechanics are interrelated in an experimental course he's developing, Micro- and Nanoscale Mechanics, and Sundararajan will incorporate his research into his surface engineering course.

Meanwhile **Cris Schwartz**, a PhD candidate in ME, is tackling issues with implants from a different angle. Schwartz, who earned BS and MS degrees at Iowa State and worked five years as a senior research engineer with Southwest Research Institute® in San Antonio, Texas, received an **NSF Graduate Fellowship** to pursue his interest in studying the mechanical properties of articular cartilage.

With consultation from his advisor, University Professor **Shyam Bahadur**, Schwartz designed and built a machine that simulates the motion of a hip or knee joint in order to conduct wear testing of cartilage. His goal was to develop a relatively inexpensive tool for researchers to use in testing different combinations of materials, narrowing down the field of options before moving forward with large-scale testing. Initial tests have validated that Schwartz' low-cost device gets results very similar to those from machines costing well over $100,000.



Schwartz is eager for a solution because he knows many people who've needed new joints, including his major professor. "Professor Bahadur got a new knee this past summer. He waited a number of years because he felt he was too young," Schwartz says. "Implants must be made to be durable so patients won't have to worry that they might outlive their new hip or knee. I hope that my research puts another resource in the toolbox of people designing the next generation of implants."

Cardiovascular disease

When **Francine Battaglia** joined the ME faculty in 1999, her research centered on computational fluid dynamics (CFD) and developing computational models to explore issues related to the thermal sciences. While that seems far removed from biomedical engineering, Battaglia, an associate professor and director of the Center for Building Energy Research, has applied her CFD expertise to some preliminary work studying blood flow within intracranial aneurysms and is intrigued by the possibilities.

In a collaborative project with **Mike Olsen**, ME assistant professor, Olsen's graduate student recreated the pulsitile motion of blood flow by using a pump and running water through an actual-size model of a blood vessel. "They used microscopic particle image velocimetry to measure the flow," Battaglia explains. "And my graduate student, **Ross Miller**, ran CFD simulations. The results compared very well, but this was just a first step in evaluating basic analysis tools."

Some 20% of joint replacement surgeries are due to aseptic loosening caused by friction and wear of the polyurethane cup of the implant as it contacts the metallic surface of the implant stem.

Another project focused on stents, wire-mesh devices placed in aneurysms to prevent rupture and also inserted in arteries to reopen them after they've narrowed due to plaque formation. Battaglia and Miller looked at how to model a stent so that more complete data on blood flow through the arteries can be gathered.

"Most models just look at the interface between the stent and the arterial wall, but ours was a 3-D geometry of the stent and aortic-iliac bifurcation, which will help us learn more about the overall blood flow," Battglia says. She emphasizes that this is very early work, but it does indicate CFD has the potential for advancing the treatment of cardiovascular disease.

Grid used for the stented aorta-iliac bifurcations—the artery is shown as a wire frame mesh and the stents are inside.

Alumni pursue biomedical careers

Michael Williams, a 2002 ME alumnus and research and development engineer with **Boston Scientific Neurovascular** in Fremont, California, designs devices to treat brain aneurysms. He's involved with the entire process from initial idea through testing, early manufacturing, and use in patients.

"The device, which looks like a miniature Slinky™, is designed to prevent the flow of blood into the aneurysm," says Williams, who earned an MS at Stanford University. "It's delivered through a catheter that goes into a blood vessel in the brain. It's challenging primarily because of size; we're working with a diameter about the size of a strand of hair. A lot of what we're doing isn't groundbreaking in terms of the technology, but we have to make it work on a scale that's 10 times smaller than anything that's been done before."

Williams credits the opportunity to work for ME Professors Judy Vance and Jim Bernard as an undergraduate research assistant for his interest in the field. "Being part of a research team and working on real projects gave me a feel for what research really means," he says. "That experience and the opportunity to take graduate classes at the end of my undergraduate studies opened the doors when it comes to working in research and development."

In St. Paul, Minnesota, **Mark Bly** is a research scientist for **Guidant Corporation**, a company that designs and develops cardiovascular medical products. He does research on the leads for pacemakers and defibrillators. The leads are the conductors that interface with the heart.

Bly, who earned his BS at Iowa State in 2001 and MS at Stanford University in 2002, says designing devices to implant in human bodies is challenging and rewarding. "The human body is very complex. You have to understand the anatomy and physiology and what the requirements are before you can design an effective product," he says.

Designing medical devices requires much dialogue with physicians and other experts throughout the process. "We need their input from the time we start with an initial concept throughout testing and evaluation," Bly says. Part of the process, too, is to generate intellectual property to protect the concepts that are developed.

Bly's interest in biomedical engineering developed as he learned more about career opportunities while on a co-op in the chemical industry. In addition to a strong understanding of engineering fundamentals, he says sound leadership, communication, and problem-solving skills are needed in the field.

Another Iowa State alumna, **Logan Dawn Williams**, is in her second year of graduate school at the University of Colorado. With a **National Institutes of Health Initiative for Minority Student Development Fellowship**, Williams is in the PhD program with the goal of doing biomedical research, teaching, and consulting with governmental officials on public policy issues.

As a research assistant working in the Cardiac Dynamics and Ultrasonics Laboratory, Williams is developing an ultrasound imaging system that could impact the ability to diagnose and monitor diseases like atherosclerosis, an abnormal hardening and narrowing of the arteries.

"In atherosclerosis, cholesterol plaques form in the blood vessels. These and dislodged blood clots can cause heart attacks and strokes," explains Williams. "You can diagnose or monitor the disease by looking at the velocity profile near the vessel wall, but current techniques don't do it very well. With the echo-particle image velocimetry system, I track the particles in an opaque fluid using ultrasound and then correlate images to determine the velocity."

Williams credits the Society of Women Engineers for getting her involved in many leadership activities.

Where do our ME graduates go?

Cargill, John Deere, Halliburton, Lockheed Martin, and the U.S. military lead the list of employers of ME graduates from 2002 to 2005. According to a survey taken just prior to graduation, 23 new alumni began their professional careers with one of them.

Nearly 160 ME students (approximately 30% of the total) responded to the voluntary survey conducted by Engineering Career Services. The majority of respondents accepted positions in the Midwest, with 58 remaining in Iowa.

Employers that hired at least two ME graduates include

Allsteel
Altec Industries
Boeing Company
Burns & McDonnell
Caterpillar, Inc.
Cargill
CIMA Labs, Inc.
Emerson Process Management/Fisher Controls
Fansteel/Wellman Dynamics
Flint Hills Resources
General Mills
General Motors
Grain Processing Corporation
Halliburton
HON Industries
Hutchinson Technology
John Deere
Johnson Controls, Inc.
Kiewit Industrial
KJWW Engineering Consultants
Lockheed Martin
Omaha Public Power District
Pella Corporation
Polaris Industries, Inc.
Rhodia Inc.
Rockwell Collins
Sauer-Danfoss Inc.
Schlumberger
Trane
Union Pacific Railroad
U.S. Military
Woodward Control Solutions

Scholarship recipients for 2005–2006

Thanks to the contributions of many alumni and friends, the Department of Mechanical Engineering awarded over $221,000 in scholarships to 134 students for 2005–2006. In addition, 56 incoming ME freshmen received about $45,000.

"Scholarships play an important role in the department," says Greg Maxwell, ME associate professor and scholarship chair. "They reward students who have done outstanding academic work, give assistance to students with financial need, and are used to recruit underrepresented minority students."

For information about the scholarship application process, visit www.eng.iastate.edu/scholarships. If you are interested in contributing to the scholarship fund, please fill out the donation form on page 7.

2005–2006 scholarship recipients

Daniel Acosta
Michelle Allen
Jeffrey Bartels
Carl Bauer
Joseph Bauer
Erin Bebar
James Beck
Shea Benter
Mark Bergstrom
Andrew Berthelsen
David Bleeker
Michael Bleeker
William Bohle
Nathan Bong
Adam Bragg
Carrie Brown
Kevin Brown
Alex Bumgardner
Adam Bunnell
Janelle Byer
Kristy Chatt
Troy Cleveland
Mark Conway
James Cox
Katelyn Craigmile
Ann Culver
Jason De Zwarte
Christopher Deal
Jesse Depping
Royal Elmore
Matthew Emerson
Nick Even
Katie Farrell
Katherine Fendrick
Brian Fick
Benjamin Fletcher
Adam Forshier
Nathan Franka
Lance Freeseman
Shuang Gao
Keegan Gartner
David Gilles
Janice Gustafson
Joseph Haluska
Brett Hartman
Blake Hasenmiller
Brice Herbers
Jeremey Heronemus
Andrew Hetland
Robert Hopp
Luke Horak
Oghenevomero Ikoba
Daniel Jensen
Lee Johnson
Mark Johnson
Matthew Johnson
Samantha Kapaun
Lisa Keele
Sarah Kelly
Stacy Kennedy
Jason Knipper
Nicholas Koren
Matt Kronlage
Jeffrey Landherr
Kelsey Lenaghan
John Little
Sara Luke
Andrew Maiers
Megan Mathias
Jonathon Mauritz
Michael McCourt
Daniel Meehan
Patrick Meehan
John Misra
Neil Modeland
Michael Moeller
Cody Monaghan
Jessica Moraniec
Matthew Morrison
Donavan Mumm
Clayton Neumann
Jean-Albert Nguyen
Simon Nielsen
Christian Noon
Barbara Nsiah
Colleen O'Brien
Kurt Olsen
Trae Olsen
Catherine Peloquin
Kaleb Pergande
Brett Pfeffer
Clifford Pinsent
Edward Plizga
Christopher Pruess
David Raithel
Jared Ramthun
Noah Rasmussen
Tyler Rasmussen
Jeremy Renshaw
Nickelous Rieck
Chris Rodriguez
Cristina Saint-Blancard
Zane Schaefer
Tyson Scheidecker
Abigail Schmoll
Jason Schott
Melissa Schraufnagel
Michael Schuller
Melinda Siskoff
Daniel Snelling
Dustin Staade
Adam Stecklein
Sean Stolper
Matthew Strasser
Elizabeth Struck
Derek Swartz
Levi Swartzentruber
Matthew Swenka
Jeffrey Thomas
Andrew Tilkes
Micah Van Mersbergen
Mark Van Thomme
Nicholas Vandewaerdt
Robert Venner
Guadalupe Vera
Mevan Vijithakumara
Rachael Waggoner
Kathryn Wagner
Christopher Wagnitz
Sarah Walter
Arlo Wieczorek
Jeffrey Wille
Adam Witthauer
Kevin Zenz

INCOMING FRESHMEN

Nathan Anderson
Nicholas Babberl
Christopher Barngrover
Jonathan Berrie
Zachary Beversdorf
Kyle Bowell
Alex Brimeyer
David Bromeier
Harrison Bucy
Nick Carlstrom
Steven Chase
Brian Cheney
Robert Cooper
Tyler Dorin
John Dunham
Tyler Fast
Zachary Friedl
Jonathan Frost
Nicole Gassman
Kevin Gehrke
Ted Gerber
Trevor Hanus
James Harmon
Benjamin Harriman
Sean Harwick
Kevin Healy
Jacob Hetzel
Josh Hockett
James Holloway
Nicolas Howard
Christopher Iacono
James Jensen
Luke Jensen
Andrew Johnson
Katie Kolega
Paul Letsche
Austin Lyons
Laura Miller
Wesley Nelson
Daniel Norwood
Jacob Paulaitis
Shane Pearson
Dominic Pham
Nathaniel Renner
Drew Robinson
Thomas Rohlfing
Jared Scanlon
Jonathan Schroder
David Smit
Gregory Swiss
Andrew Theobald
Noah Van Dam
Justin Voss
Aaron Walters
Loren Zabel

D.C. internship focuses on policy issues

Since arriving at Iowa State in 2002, **Sarah Walter** has been involved in campus and departmental activities. Last summer, she took her involvement to a new level. One of eight students selected from across the United States to participate in the Washington Internships for Students of Engineering (WISE) program, she spent nine weeks learning how engineers can have a voice in the federal government.

Students apply for WISE through professional engineering societies that fund the program with support from the National Science Foundation and the American Association of Engineering Societies. The internship provides an in-depth look at how policy issues develop into laws and the role engineers play in the political process. Each intern researches a self-selected topic and writes a comprehensive policy paper.

Walter, who was sponsored by the Society of Automotive Engineers (SAE), did her research on corn ethanol as an alternative fuel for automotives. She visited with industry representatives, met with members of the Department of Energy and the Department of Transportation, and conducted interviews with ethanol supporters on Capitol Hill. Walter's paper will be published in the SAE Technical Paper Series during the 2006 World Congress.

The July 29 passage of the first major energy bill since 1992 made this summer an opportune time for Walter to be in the nation's capital. "Congress makes decisions that affect everyone," she says. "Our legislators and senators rely on the expertise of engineers and scientists to make informed decisions on technical issues. If we're not engaged in policy making, where will that information come from?"

After completing a fall co-op at Rolls Royce in Indianapolis, Walter will be back on campus to share her WISE internship experiences with her Iowa State peers. "What happens in Washington, D.C., affects all of us," she says. "We have to be engaged."

Your support makes a difference

Generous gifts from ISU ME alums, industry, and others enable our department to continue our tradition of academic excellence. Your contributions are used for

- Scholarships and fellowships
- Start-up funds to attract top-notch new faculty
- Seed money for development of new projects
- Laboratory equipment

In 1980, **Henry Black**, department head from 1946 to 1972, joined with **Hollis "Pete" Hilstrom**, ME'34, to invite alumni to contribute to the Black-Hilstrom Mechanical Engineering Development Fund. Since then, the endowment has grown to more than $2 million with gifts from more than 475 alumni.

Please use this form to contribute or call us at (515) 294-1423 to learn about other ways you can support ISU ME.

The Black-Hilstrom Fund

An Endowment for Mechanical Engineering

☐ I enclose $_____ by check made payable to the ISU Foundation and designated to the Black-Hilstrom Fund.

☐ I pledge $_____ to be paid in ___ installments over ____ years. Please remind me each year in _____ (month). Enclosed is my first check for $_____ made payable to the ISU Foundation and designated to the Black-Hilstrom Fund.

☐ I am interested in information on establishing scholarships.

☐ I would like information on planned giving.

☐ I have included the College of Engineering in my estate plan.

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Degree(s)_____ Year(s) granted _____

Address_____

City_____ State_____ Zip_____

My gift ☐ does ☐ does not qualify for a company matching gift.

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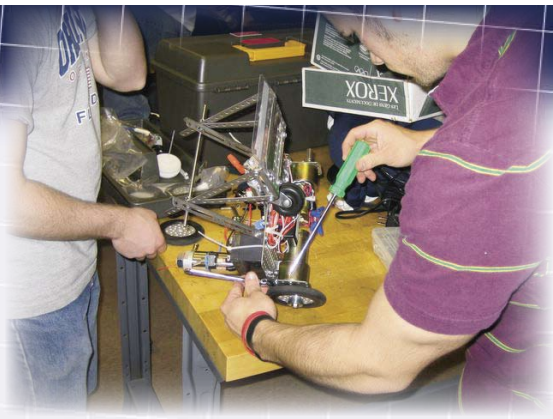
Robotics kits bring lab to life

From left, Kelsey Lenaghan, Neal Schurr, and Curtis Nielsen work on their robot.

Although Engineering 170 is the first graphics and design course new engineering students take, instructors **Denis Dorozhkin** and **Andrew Fischer** wanted their students to be able to actually build their designs. They looked for robotics kits to add to the lab's resources. "We feel students learn a great deal more if they can go beyond simply outlining potential solutions on paper or on a computer screen," says Dorozhkin. "By building their designs, they can see for themselves if the solution actually works and how well it fulfills the original problem statement."

With the kits, students learn by trial and error and gain experience addressing assembly issues and meeting specific criteria at various testing stages. And they have fun doing it. "That," Dorozhkin and Fischer agree, "helps them understand and retain the theoretical material."

Dorozhkin and Fischer, who are PhD students, coordinated the purchase of the18 robotics kits to accommodate two sections (36 students each) of the course. Money from the Raymond A. and Kathryn A. Engel Fund was used to purchase the kits.



Students working on their project in the lab.

Alumni and corporate donations are critical to maintain state-of-the-art experiences for ME undergraduate students.

ME Update is published twice a year by the Department of Mechanical Engineering at Iowa State University and is prepared by Engineering Communications and Marketing. Please send comments to: ME Department, ISU, 2025 Black Engineering, Ames, IA, 50011-2161. Phone: 515 294-1423; Fax: 515 294-3261; E-mail: isume@iastate.edu; Web site: www.me.iastate.edu