Iowa State University
College of Engineering
ME UPDATE
Summer 2004 Newsletter Volume 13 Issue 2

Professor aims to meet industry need

Professor Mike Pate, left, shows the new equipment donated by Ingersoll Rand for his class in compressed air systems to grad student Ryan Warren.

The equation is simple—industry demand plus engaging professor equals one very popular course. The ME department boasts just such a course, ME 443, Compressed Air Systems. Professor **Mike Pate** started the class three years ago at the urging of two trade associations, the Compressed Air Challenge and the Compressed Air and Gas Institute.

"I had interacted with Floyd Barwig, director of the Iowa Energy Center, on several energy projects, and he connected me with the associations because they wanted prospective employees to learn about compressed air," Pate explains. The reason is simple. "Compressed air is the most common way to operate machinery and equipment in plants; therefore, the greatest proportion of a plant's utility bill is for the electricity used to run the compressed air. Factories and industrial facilities have engineers who are in charge of compressed air and whose goal is to make it work as efficiently as possible. This class is designed to help them know how to do that."

As word of the class has spread, enrollment has increased from 50 students in 2002 to 70 in 2003 and 85 this year. The 2004 class is the first to get hands-on experience with the newly installed compressed air system donated by Ingersoll Rand. "The companies in the trade associations are eager to help," Pate says. "They provide guest lecturers as well as equipment and other supplies." As a result, students can come to the lab and work with the system, opening and closing valves to see firsthand how different settings affect the system's operation.

Starting a new university course is tough anytime, but in this case it was especially difficult because the class is unique. Pate, however, relishes the challenge. "Industry wants prospective employees to have this experience, and students want the opportunity. It's all part of the educational process, and I love being a part of it."

Leia Guccione moves full speed ahead

From founding a sorority for women in technical studies to serving as public relations chair for the Society of Automotive Engineers (SAE) to helping carry the VEISHEA torch across Iowa, ME senior **Leia Guccione** has been a vibrant and contributing member of the Iowa State community since arriving on campus in fall of 2000. In recognition of her outstanding achievement in academics and extensive involvement and leadership in university activities, she was one of four students who received the Wallace E. Barron All-University Senior Award for 2004. The award includes the official Iowa State University ring, compliments of the alumni association.

A midshipman in the Iowa State Naval Reserve Officers Training Corps, Guccione began her studies at Iowa State in political science. A naval science course on ship engineering systems sparked her interest in energy and power systems, so she decided to major in mechanical engineering as well.

Owner of an impressive list of leadership activities, Guccione is especially proud of a recent accomplishment as

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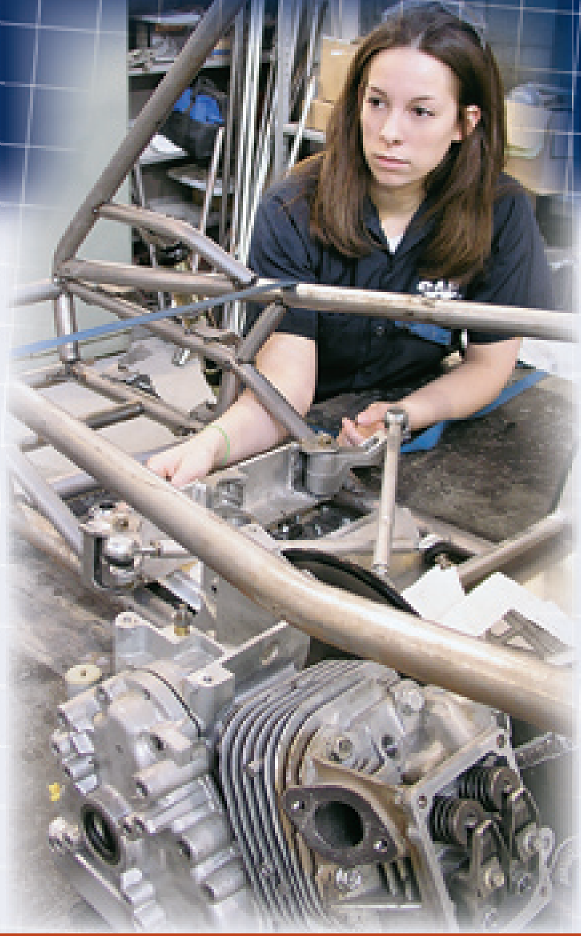
INSIDE THIS ISSUE:

Sarah Walter eyes all-women's team



The daughter of a mechanic, **Sarah Walter** learned a lot about the nuts and bolts of cars while growing up in West Chicago. As an ME major, she eagerly joined the mini-baja team so she could help design and build a car. In her freshman year, she became the first female captain of the ISU team.

Now, to encourage more women to participate, she's starting an all-female team. "We've got the skills and know-how," Walter explains. "But when the majority of other members are guys, it can be intimidating. An all-female team will help members gain confidence in their abilities."

She's been talking to potential members about the benefits and hopes to have 20 women signed up by fall. Supporting an additional team will require intensive fund-raising. "It costs between $17,000 and $20,000 a year to design, build, and test a car, so we'll need to get sponsorships," she says. Finally, there's the matter of space. Three teams will need to be able to coexist in the same space so they can share the tools and equipment. For Walter, the effort will be worthwhile. "My participation in SAE helped me get a co-op at Rolls Royce in Indianapolis," she says. "I want other women to get the kind of hands-on experience that will help them succeed."

Students gain a wealth of experience

ME seniors (from left) Jason Tracy, Andy Elis, and Dan De Clute work on the formula car.

Say the words "Cyclone team" and intercollegiate athletics pop to mind. But there are all kinds of teams at Iowa State preparing for specialized competitions, and two of these are under the auspices of SAE (Society of Automotive Engineers). They are the formula car and mini-baja teams. Their mission: design, build, and test their vehicles for competitions with collegiate teams from around the world.

The team members get an amazing amount of hands-on engineering experience, according to **Joel Smeby**, ME senior and SAE president. "Each year the vehicles are built from the ground up," he explains. "We use computer-aided design technology to model and assemble all parts of the cars in the computer interface. Our parts also undergo finite element analysis to insure that the car will survive the rigors of competition while maintaining a low vehicle weight. It's become a very sophisticated process."

Smeby says that the overall focus of SAE, which has 150 paying members, is to help students develop skills and make contacts that will help them in their careers and, at the same time, help publicize automotive engineering as a profession. The cars provide an excellent focal point. "We give talks at high schools and at events like ISU Scholar Days and the Iowa Science and Technology Fair. We also lead groups on tours through our shops," he says.

This year's formula car has the unique characteristic of using E-85 (85 percent ethanol) to run the engine. "We're promoting Iowa by using corn-based fuel," says **Leia Guccione**, SAE public relations director. Gas currently sold in Iowa is 10 percent ethanol, so successfully demonstrating the use of E-85 could have a dramatic impact on the state. The effort has brought positive attention to the team and has given the members opportunity to talk about the benefits of E-85. They've worked with the Iowa DNR, participated in events at the Iowa capitol, and were featured in the February issue of ***Ethanol Today***, the official magazine of the American Coalition for Ethanol.

Another aspect of the club's work is raising money. The formula car alone costs around $25,000 a year. Donations from businesses and individuals are crucial.

For more information about the teams and about sponsorships, please visit www.cyclone-racing.com.

Robots capture youth interest

Jake Ingman, right, talks to students about the FLL challenge.

Jake Ingman loves working with robots. As a youth, he had a passion for building and fixing things. That desire to tinker, as he describes it, landed him at Iowa State as a mechanical engineering major. Today, Ingman views robotics as a great tool for introducing children to the exciting world of engineering.

Evidence of his efforts occurred December 6th when 27 teams of 9–14-year-old students converged on Hoover and Howe Halls to participate in the 2003 State of Iowa FIRST (For Inspiration and Recognition of Science and Technology) LEGO League (FLL) Tournament. Designed by LEGO™ and FIRST to teach children the fundamentals of engineering, problem solving, and teamwork, FLL tournaments are held worldwide.

Ingman, along with fellow ME student **Casey Fennell** (now an alum), co-chaired this third annual event held in the College of Engineering. To help create interest, they visited schools telling students about FLL. Ingman sees FLL as a way to attract more girls as well as minority students to engineering. "We talk to the younger students and demonstrate with LEGOS™. They've all played with them so they have the confidence to try," he explains. "It's cool to be able to get their interest and expose them to all of the opportunities."

Presented with the challenge in September, the teams have eight weeks to plan, design, build, program, test, and refine a fully autonomous robot capable of completing specific tasks. At the tournament, they are judged on robot design and performance, research presentation, and teamwork. The all-day event is planned as an outreach activity to showcase the college. As interest in the competition has grown, the logistics have gotten more challenging, says Ingman, chair of the 2004 event. "We packed the halls in 2003, so we're currently discussing ways to deal with all of the interest."

Ingman, who graduated in May, began graduate studies in Iowa State's new Human Computer Interaction Program this summer.

For more information about the Iowa FLL tournament www.eng.iastate.edu/techknow/FLL/.

CyMix team heading for space

ME students **Clayton Neumann**, at left, and **Kevin Schroeder**, on co-op with Lockheed Martin, are using their ME knowledge to build a blender to process food in space—the challenge is to design a device that doesn't need gravity to work. They are members of Team CyMix headed by biology major **David Chipman**. In July, the team will travel to NASA's Johnson Space Center as one of the 70 undergraduate teams from across the nation selected to participate in the Reduced Gravity Flight Opportunities Program.

For Neumann, the project has provided a real-world learning opportunity that goes beyond the engineering aspects. "The most important thing has been developing teamwork skills," he says. "We've applied for funding grants from various groups, and we made a poster and talked to elementary school kids about our project. It's been a fun experience!"

Guccione continued from page 1

a Government of the Student Body senator. "I led the charge to override the presidential veto for Engineers Without Frontiers (EWF)," Guccione explains. EWF is a new ISU chapter of an international organization aimed at providing opportunities for students to work on engineering projects in developing countries that introduce or improve infrastructure.

After her December graduation Guccione will be a commissioned officer in the Navy, serving on a ship for two years and then attending nuclear power school. Eventually she hopes to be involved in alternative energy policy at the national level. She's getting great firsthand experience related to alternative energy with her work on the Society of Automotive Engineers formula car team, see story on page 2.

Virtual reality research—Pushing the edge . . .

Virtual reality (VR) is cool. Put the glasses on and step into Iowa State's C6, and you enter another world. For the casual visitor, it's a chance to walk through a Hindu Temple or crawl inside a supercell thunderstorm. For seven ME researchers, however, it's a powerful tool with unlimited potential. Their work covers everything from designing complex farm vehicles to determining energy-efficient floor plans for industry; from developing evacuation plans for volcanic eruptions to maximizing the performance of unmanned aerial vehicles.

Traditionally, 2-D computer models on 17-inch monitors helped create and display a product, such as a car. With VR, the design is transformed into a life-size model that the engineer can walk around and peer inside of. The manufacturer doesn't have to "invest the time and resources to build and test each design," explains **Jim Bernard**, Anson Marston Distinguished Professor of Engineering. He describes the research at Iowa State's Virtual Reality Applications Center (VRAC) as pushing the edge, finding ways to do things better in the future.

"We provide a way for companies to explore what's possible while assuming little risk," adds **Jim Oliver**, VRAC director and ME professor. "Once we demonstrate how VR can enhance product development, companies can go to their suppliers and say 'this is what we want.'"

Creating realistic simulations is a challenging task requiring massive amounts of data and sophisticated technology, according to **Judy Vance**, professor and ME department chair. "The key is realism. We are attempting to evaluate designs using computer images instead of actual prototypes. The more accurately we can model the real world, the more value VR brings to the design process."

Here are some of the exciting areas ME researchers are investigating.

Bernard, an expert in vehicle dynamics, is working with ME Associate Professor **Greg Luecke**, whose focus is control systems, robotics, and haptic feedback (information coming through the sense of touch). The goal

ME faculty in front of C6 are (left to right) Jim Oliver, Eliot Winer, Judy Vance, Atul Kelkar, and Jim Bernard. Not pictured: Mark Bryden and Greg Luecke.

is to develop virtual models of control systems for farm machinery that will work in "real time," that is, the human driver can actually feel how the vehicle is handling while operating a computer-controlled simulation. "By placing the human inside the computer model and providing a realistic simulation, we can see how he or she interacts with the vehicle," Bernard says. "Besides being able to determine if operators can see over the dashboard, we want to know if they can comfortably operate the control levers and what types of levers and controls are appropriate for what types of actions. Virtual reality provides us the environment to do this without creating expensive one-of-a-kind physical prototypes."

Another application of virtual controls is remote vehicle operation. A major challenge here is addressing the time lag that occurs in the transfer of information between the human operator and the virtual environment. "You don't want to be sending commands to dig if the robot has just completed a turn in a new direction as a result of a previous command," Luecke explains. He is also using haptic feedback within virtual reality to provide the operator with more sensory feedback from the virtual machine. "You have to have some idea of the environment the robot is touching—has it hit a rough spot, has it encountered something hard—so you can tell it how to respond." Luecke is developing models to send force information about the remote environment back to the operator in order to develop better remote control algorithms.

Atul Kelkar, ME associate professor, focuses on the design and development of control system architectures that combine mechanical, electrical, and hydraulic components for high-value equipment such as tractors and front loaders. "To test the total design methodology, we need a human-in-the-loop, i.e., someone operating the controls and actually experiencing how they work." Last fall, the researchers demonstrated a virtual front-end loader with a person operating the steering, the boom, and the bucket with a joystick. A future research direction is to incorporate the terrain model and the motion base for the operator. The motion base will allow the driver to feel the bumps in the road and experience how the vehicle responds.

"The more accurately we can model the real world, the more value VR brings to the design process."

Vance is involved in creating a virtual environment to simulate product assembly. Once a new part has been designed, virtual reality provides a means for determining how to best assemble the part. "We want to bring the shop floor workers into a virtual environment to perform the actual steps it takes to manufacture a product," she explains. "From their experience, we will be able to plan the manufacturing better before the first product is built." In virtual reality a person can reach out and "grab" a digital three-dimensional object. The difficulty in simulating an assembly process is to simulate how the parts interact. In the real world, when two objects touch, their surfaces interact. Two objects in the virtual world can penetrate each other unless sophisticated mathematics are used to determine contact and behavior.

Associate Professor **Mark Bryden** is using his expertise in numerical modeling and computational fluid dynamics (CFD) to incorporate analysis tools into VR applications for use in thermal systems design. The area is broad—he's working on tools for chemical processing plants, power plants, and even hog enclosures. "We bring in the equations and modeling tools so the data can be assessed and linked with the visualization," Bryden says. As a result, the farmer, for example, without expertise in CFD, has the information he needs to make informed and timely decisions about his facilities. Using VE Suite, an Open Source software package, as the basic tool, Bryden brings numerical data and models into a single system for examination.

ME's newest researcher in VR is **Eliot Winer**, an assistant professor who is collaborating with researchers at the University of Buffalo. "I'm building a system to visualize the massive amounts of data required to assess volcanic eruptions. If a volcano is about to erupt, you have to quickly gather data, run simulations, assess the situation, and develop and implement a plan to get everybody out safely," Winer says. In addition, the system must be deployable anywhere and accessible on any platform—from high-end immersive virtual environments to PDAs—so scientists from different locations can collaborate. This methodology, Winer explains, can be applied to a variety of engineering problems such as biomedical imaging or automobile design where the goal is to visualize very large amounts of complex data from different sources.

Oliver, who was named VRAC director last winter, is breaking new ground with a proposal to enhance the performance of unmanned aerial vehicles (UAVs). "The operation of UAVs poses two critical challenges," Oliver says. "First, the operator's view is very narrow, like looking through a drinking straw, so he can't see what's going on around the vehicle. Second, there's the time lag. The further the UAV is from the operator, the longer it takes to transmit a signal. By the time the driver sees a hazard, it's too late to avoid it." Oliver's team has conducted preliminary work developing solutions to these problems and is now seeking support to pursue the research.

"It's an exciting project with great potential for the military," he says. "Currently, two people operate each UAV, and it's so demanding that shifts are limited to two hours. The goal is for one person to be able to drive multiple vehicles." The VRAC research could help them reach that goal.

Faculty live and learn abroad

Professor Jerry Colver in Burgsteinfurt, Germany.

Two months in France, two weeks in Germany, a week in Japan—take a look at Professor **Jerry Colver's** itinerary for fall semester, and it sounds like a dream vacation. While he incorporated some sightseeing, Colver's Faculty Professional Development Assignment (FDPA) focused on getting firsthand experience with specialized technologies that apply to his research areas: powders combustion, fluidization, and electrostatic effects in powders.

Colver achieved his goal and more. "I wouldn't trade it for anything," he observes. "I learned so much—not just the technical exposure, but seeing how the universities operate, interacting with the people, and learning to accomplish daily tasks, like grocery shopping, with limited French and German skills." He says the experience gave him insight into what international students face when they move to Ames and must adapt to American customs. Colver had the added challenge of living as a single guy since his wife and a son stayed home to keep things going there. They were able to join him for a two-week visit, and the three of them traveled to Germany to see another son, Erik, who lives in Burgsteinfurt.

While at the University of Poitiers in France, Colver collaborated with Professor Gerhard Tuchard, known for his work in electrical discharge and powder-related phenomena, on a study of gaseous discharge effects. The work has implications for Colver's current NASA research in powder combustion as well as potential for future proposals that address safety issues for aircraft and space vehicles.

At Aachen University of Technology in Germany, Colver learned about two modern approaches involving experimental and numerical investigations used in flue gas analysis. He says the experience will impact both his graduate course in multiphase flow and his combustion research. The final leg of his journey was to Awaji Island in Japan where he presented an invited lecture on electrostatic charge effects of powder at the 12th Nisshin Engineering Particle Technology International Seminar.

Another ME faculty member, Associate Professor **Greg Luecke**, also traveled great distances on his FDPA. Accompanied by his wife and two children, he headed to the "land down under" in early July for a six-month stay.

Luecke, whose research focus is using robotics as an interface for virtual reality, arranged to spend his leave in the computer science department at the Australian National University in Canberra. Their expertise in haptics—that is, giving the human operator the ability to touch and feel in the virtual environment—appealed to Luecke.

"The people in Australia are using virtual reality as a surgical training device," Luecke says. With their technology they can see, feel, and manipulate three-dimensional virtual objects. A surgeon in one location, for example, can guide another doctor's hand through a training procedure.

The FDPA provided Luecke the opportunity to share expertise with another group of researchers and expand his research to some new areas. Back in Ames, Luecke and his graduate students are applying what he learned in Australia to pursue ways to eliminate the time lag in sending to and receiving information from robots.

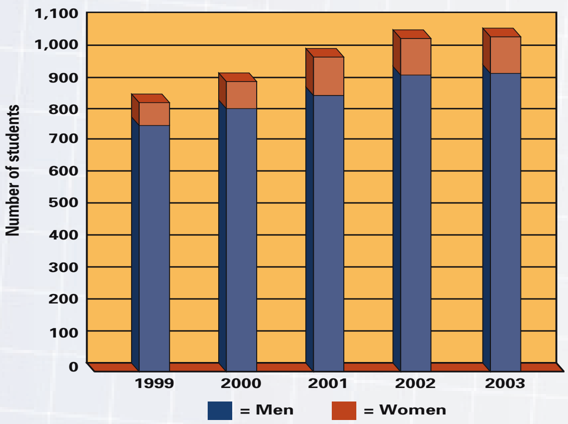
ME Associate Professor Greg Luecke with ISU ME Students John Burnett (standing) and Scott Buse.

Luecke found the overall experience of living in Australia for six months both rewarding and challenging. "English is the official language so we didn't have to deal with a language barrier, but there were things we had to get used to," Luecke says. "They're not quite the go, go, go society that you get here. There aren't any Wal-Marts open 24 hours a day."

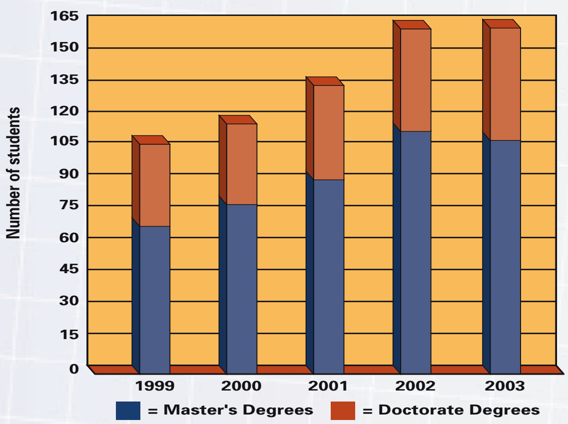
The Lueckes spent nearly every weekend on the road visiting the marvelous sights of Australia. "When the kids got out of school, we went on trips traveling over 20,000 miles in all," he says. From visiting the pristine beaches along Australia's 16,000 miles of coastline to throwing a "shrimpie on the barbie" at the city parks, he observes, "it was a great learning experience."

ME enrollment statistics

Undergraduate Students



Graduate Students



Mechanical engineering's second-largest female graduating class

From bottom: Emily Hoglund, Abby Wakefield, Dawn Williams, Mary Matthews, Jessica Riedl, Stephanie Yungk, Jesse Bernstein, Megan Mohrfeld, Teresa Falck, Ellen Brockmann, Carol Aplin, Margaret Head, Shawnee Burdick, Jessica Chandler, Jessica Rose, and Melissa Meyer. Not pictured: Theresa Williams.

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CyCADET rides the "weightless wonder"

Ten days spent at NASA's Johnson Space Center in Houston culminated in the ride of their lives for a select group of engineering students this past March. The ride was aboard NASA's "weightless wonder," the KC-135A aircraft. The students—**David Shoemaker**, ME 4; **Andy Tekippe**, AerE 4; **Tyler Rasmussen**, ME 1 (pictured left); and **Mike Sparks**, AerE 4—along with other team members **Tom Calgaard**, AerE 4, and **Tom Cunningham**, AerE 1, designed, fabricated, and assembled a satellite, named CyCADET, to determine how it would perform in a microgravity environment.

Shoemaker, the project manager, wrote the proposal to test the performance of CyCADET as part of NASA's Reduced Gravity Student Flight Opportunities Program. CyCADET, which stands for control and attitude determination evaluation testbed, is a prototype for CySat, Iowa State's entry in a worldwide program to design pico satellites for launch in 2005.

While the CyCADET team encountered a few problems in flight, Shoemaker says it was a great opportunity. "The experience was, for the most part, a successful experiment in engineering. We had a great time floating in microgravity and also acquired a wealth of knowledge about engineering."

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

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