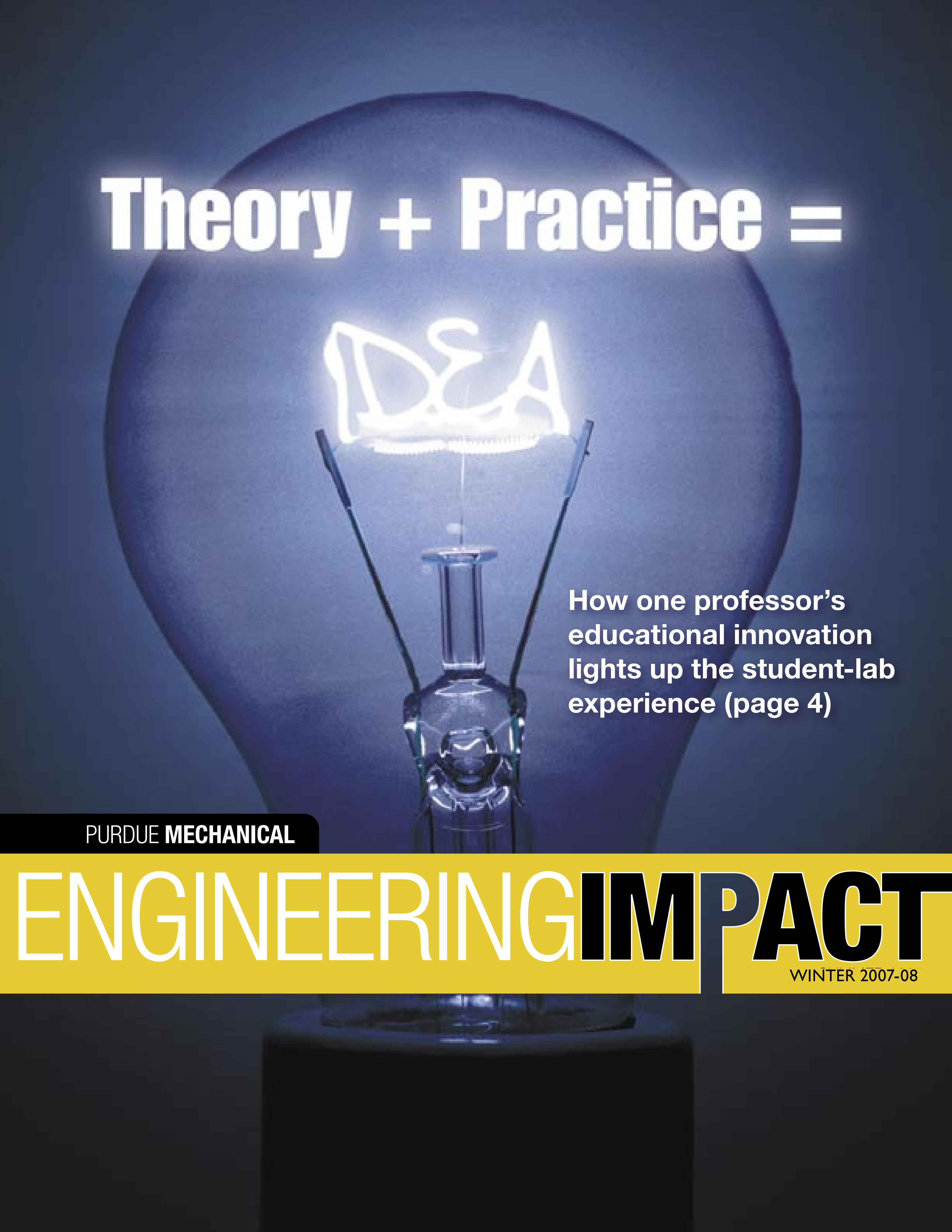
PURDUE **MECHANICAL**

ENGINEERING**IMPACT**

WINTER 2007-08



Theory + Practice =

How one professor's educational innovation lights up the student-lab experience (page 4)

From Dan's Desk

We are on the fast track now! About 80 years after it was first envisioned, the Roger B. Gatewood Wing of the Mechanical Engineering Building has moved through schematic design, and we will be putting a shovel in the ground in 2008. By the time we begin writing the summer issue of *Engineering Impact* magazine, we should be able to report a timeline for construction and occupancy. This long-awaited addition will provide much needed space for student learning and cutting-edge research. Thanks to all of you who supported The Campaign for Purdue.

And there is more exciting news about the Gatewood Wing. We will design and build to meet the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ specifications, targeting the Silver level. This will be the first building on Purdue's campus to be built to meet LEED requirements.

This issue of *Engineering Impact* focuses on education and the challenges we have in ensuring that our graduating MEs have all of the tools necessary to succeed. The Gatewood Wing will provide the physical infrastructure needed to provide for experiential learning as well as the multidisciplinary and interpersonal skill sets required for success. However, we still need to furnish and equip this additional space, and there are ample opportunities for you to help make it the world-class learning and research facility we all want it to be.

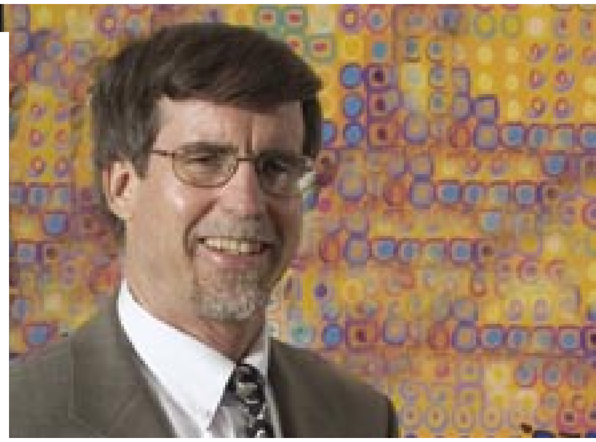
In addition to our building program, another focus of our campaign was adding faculty to decrease our student/faculty ratio and expand our research capabilities in critical areas like energy, nanotechnology, and biomedical engineering. The School is at an all-time high of 58 faculty, and our strategic plan has us growing by another 10 or so. Our faculty are outstanding, as is the demand for their expertise. Sponsored research, one measure of the relevance of our work to industry and government agencies, continues to grow rapidly. After successfully achieving these goals, we are eager to tackle the next set of challenges.

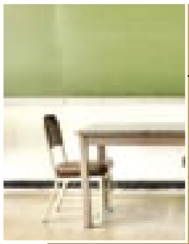
We have two more long-needed infrastructure programs to fund: Herrick and Zucrow Laboratories. The Herrick Laboratories campaign is our highest priority, and we are nearing the first-phase goal of $11 million. The plans for the new Herrick Laboratories include the Living Lab – A Sustainable Building Incubator. This lab will test new technologies for the next generation of green buildings that will focus on occupant health, safety and productivity, security, and customer satisfaction in addition to even greater advances in sustainability for energy and environment. Both of these facilities are devoted primarily to research and graduate education, so they will have to be built with private funds (State money is not available for research facilities).

Thanks to your support, a Purdue mechanical engineering degree has never been more valuable.

Dan

E. Dan Hirleman
William E. and Florence E. Perry Head
School of Mechanical Engineering





From the Editor

In this education-themed issue, we're pleased to present a number of perspectives on how Purdue mechanical engineering students are learning their discipline and equipping themselves to thrive as practicing engineers.

On page 3, William B. White, the president of E. I. Du Pont Canada Company and the chair of Purdue's Mechanical Engineering Advisory Committee, writes about the changing climate in which we're educating students—and the high standards that Purdue ME has set for developing a wide range of skills in these future engineers. In our cover story (see page 4), you'll read how one innovative professor has upended the traditional student lab to bring theory and practice together. Our "Up Close: Students" department (page 10) features a handful of ME senior-design participants who ventured into "global engineering" by prototyping a solar oven for use by Tanzanians, and in "Up Close: Faculty," we celebrate some of ME's most outstanding teachers (page 8).

All this fits into the larger context of Purdue Engineering's goal of transforming the educational experience of students across the college. From ME's leadership in offering global educational opportunities to its ambitious goal-setting for its own accreditation—and, by extension, for its students—your school is at the forefront. ■ **Lisa Hunt Tally**

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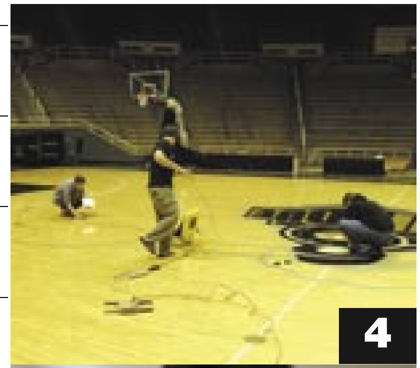

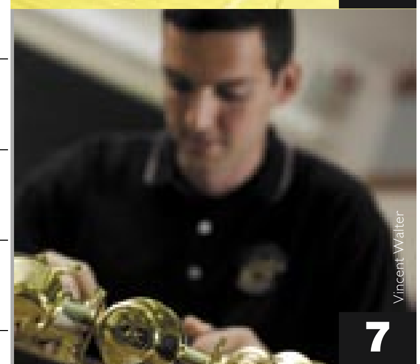

Vincent Walter

PURDUE UNIVERSITY
COLLEGE OF ENGINEERING

School of Mechanical Engineering

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Variable Valve Actuation

A radical engine redesign would reduce pollution and oil consumption.

Gregory Shaver, from left, and graduate student David Snyder discuss how to modify a commercial diesel engine. Graduate student Gayatri Adi (background) reviews software algorithms needed for the new technology.

Researchers have created the first computational model to track engine performance from one combustion cycle to the next for a new type of engine that could dramatically reduce oil consumption and the emission of global-warming pollutants.

"We're talking about a major leap in engine technology that could be used in hybrid cars to make vehicles much more environmentally friendly and fuel-stingy," says Gregory Shaver, an assistant professor of mechanical engineering at Purdue.

A key portion of his research, based at Purdue's Ray W. Herrick Laboratories, hinges on designing engines so that their intake and exhaust valves are no longer driven by mechanisms connected to the pistons. The innovation would be a departure from the way automotive engines have worked since they were commercialized more than a century ago.

In today's internal combustion engines, the pistons turn a crankshaft, which is linked to a camshaft that opens and closes the valves, directing the flow of air and exhaust into and out of the cylinders. The new method would eliminate the mechanism linking the crankshaft to the camshaft, providing an independent control system for the valves.

Because the valves' timing would no longer be restricted by the pistons' movement, they could be more finely tuned to allow more efficient combustion of diesel, gasoline, and alternative fuels, such as ethanol and biodiesel, Shaver says.

The concept, known as variable valve actuation, would enable significant improvements in conventional gasoline and diesel engines used in cars and trucks and for applications such as generators. The technique also enables the introduction of an advanced method called homogeneous charge compression ignition, or HCCI, which would allow the United States to drastically reduce its dependence on foreign oil and the production of harmful exhaust emissions.

The homogeneous charge compression ignition technique would make it possible to improve the efficiency of gasoline engines by 15 percent to 20 percent, making them as efficient as diesel engines while nearly eliminating smog-generating nitrogen oxides, Shaver says.

This improved combustion efficiency also would reduce emission of two other harmful gases contained in exhaust: global-warming carbon dioxide and unburned hydrocarbons. The method allows for the more precise control of the fuel-air mixture and combustion inside each cylinder, eliminating "fuel rich" pockets seen in conventional diesel engines, resulting in little or no emission of pollutants called particulates, a common environmental drawback of diesels. ■ **Emil Venere**

Welcome to New Faculty

Nicole Key: expertise in aerothermal aspects of turbomachinery flow fields, including the effects on component performance and durability.

Masaru P. Rao: expertise in the development of novel microfabrication technologies for applications ranging from microelectronics to biomedical microdevices.

Jeffrey F. Rhoads: expertise in the predictive design, analysis, and implementation of resonant micro/nanoelectromechanical systems (MEMS/NEMS) for use in chemical and biological sensing and/or inertial sensing systems; the behavior of parametrically excited systems and coupled oscillators; and the behavior of mechanical and/or electrical parametric amplifiers.

Xiulin Ruan: expertise in nanoscale heat transfer and energy conversion, which include nano-structured photonics, optoelectonics, and photovoltaics; laser spectroscopy of nanostructures; thermal radiation in nanostructures; multiscale simulations of materials; and thermoelectric materials and nanostructures.

Fu Zhao: expertise in design for the environment, environmentally conscious manufacturing, industrial ecology, life-cycle assessment, and alternative energy.

Staying Ahead of the Curve

William B. White is president of E. I. du Pont Canada Company and chair of Purdue's Mechanical Engineering Advisory Committee.

Staying ahead of the curve in any business is tough, but I'm learning it is even harder in education. Maintaining a differentiated value proposition in today's environment is like walking up a down escalator. Advancements with new and different value are required just to keep up—staying still is really falling backward. In education, while the fundamentals like the basic laws of thermodynamics and fluid mechanics are still the necessary and critically important foundation, knowing, learning, and using the latest ways to advance and apply them is the requisite for being relevant and competitive.

We all know the speed of change is now incredible. My generation thought the slide rule being replaced by calculators was a big deal, but handheld computers more powerful than the computers used to put Neil Armstrong on the moon becoming the tool of students in the classroom was inconceivable. CAD replacing the drafting board has rapidly evolved, and every one of our ME students today has access to computer codes that can compute three-dimensional flow fields in complex geometries and provide three-dimensional visualization of that data and multisensory discovery and learning.

The speed of the global, information-enabled market demands ever shorter cycle times between innovative concept to delivery of an end product to the marketplace. Clear images of 50-nanometer carbon tubes were published in 1952, but the scientific community was not fully aware of nanotubes until the early 1990s—a lag time of about 40 years. Carbon nanotubes are now being grown in Purdue's Discovery Park Birck Nanotechnology Center by ME faculty member Tim Fisher, delivering the engineering realization of that scientific concept. Suresh Garimella, another ME faculty member, is already applying those practically produced nanotubes working with others to use carbon nanotubes in cooling technology for microchips.

The grand challenge in mechanical engineering education is to take the incoming freshmen and equip them with all of the fundamentals that you and I learned and add to that all of the new knowledge (now doubling every one to two years), plus the communication, foreign language, interpersonal, business, and multicultural skills necessary to produce a globally competent mechanical engineer—and do it all in the same four years that we took decades ago.

As challenging as this is, Purdue's School of Mechanical Engineering has the highest standards and is on the leading edge in educating in many of the attributes for its graduates far beyond those required by ABET. (ABET is the recognized accreditor for college and university programs in applied science, computing, engineering, and technology.) Purdue's standards for Leadership; Decision-making; Recognition & Management of Change; Ability to Work Effectively in Diverse & Multicultural Environments; Innovation; Work Ethic; Adaptability in a Changing Environment; and Entrepreneurial and Intrapreneurial Skills are all set above the ABET standards.

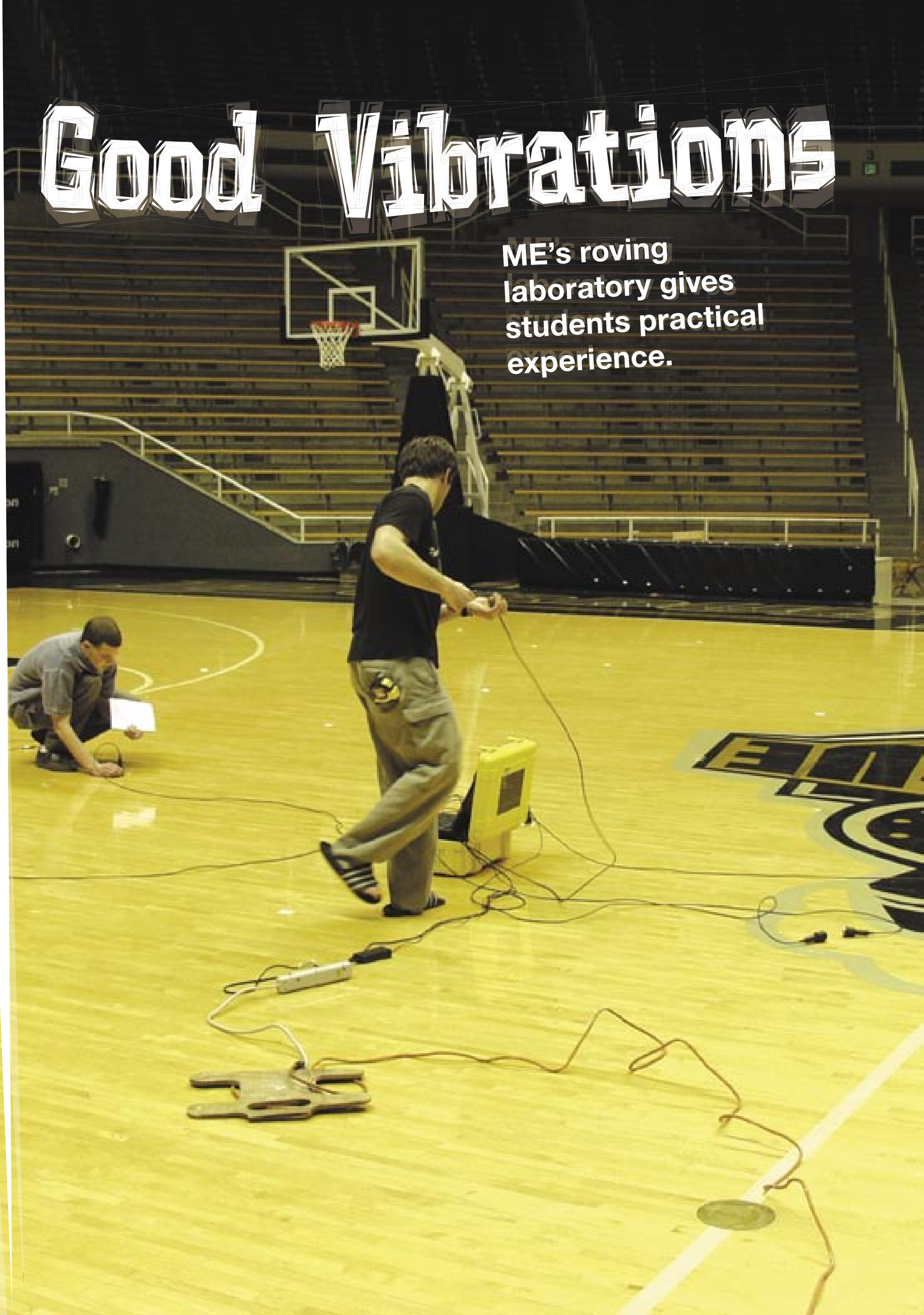
As an international employer, I appreciate and applaud the vision and results-delivery of the School of Mechanical Engineering faculty. They recognize that the demands on engineers are rapidly and ever changing and that the curriculum and student learning must stay ahead of the curve. They see this as a challenge only the best schools can meet. The easy way out for others is to be satisfied with just "meeting the standard." But that is not a character trait of our faculty—they want nothing less than to be the best. The Purdue standard of preeminence is an attribute of the Mechanical Engineering school that has kept it highly respected and top-ranked for decades.

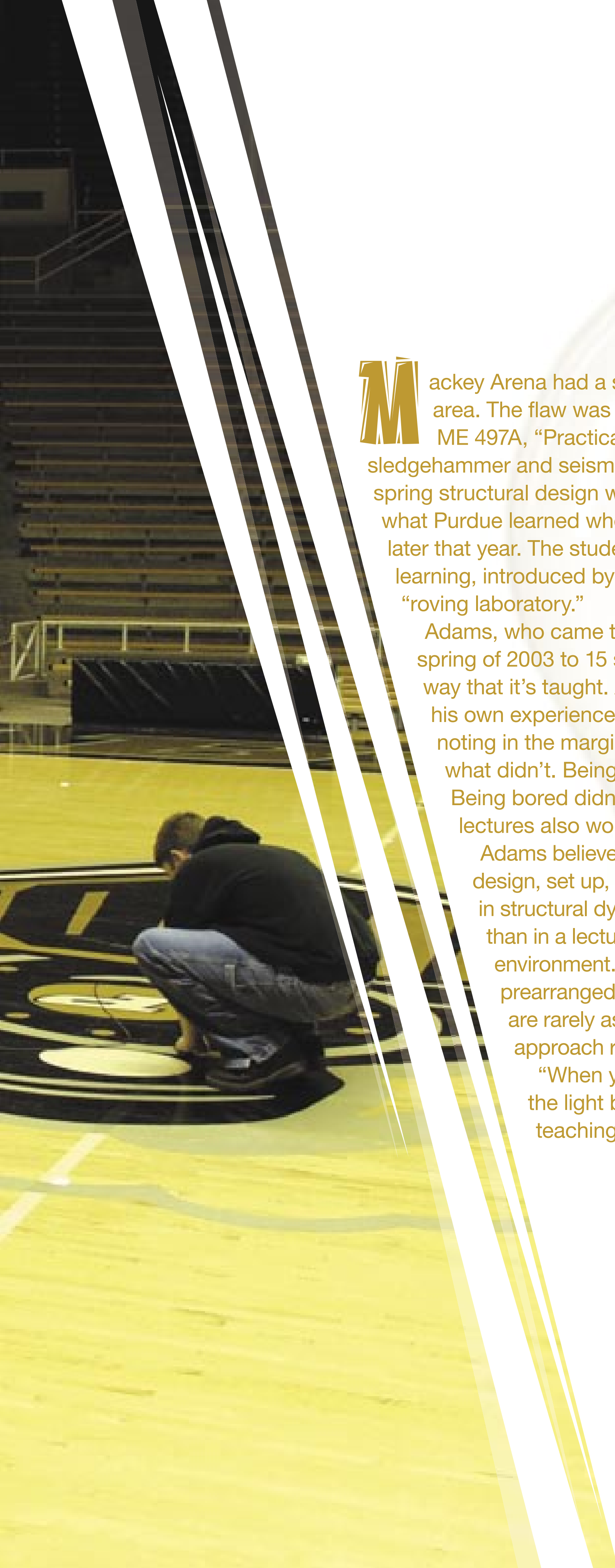
"In my view," I see that our legacy and our value as Purdue mechanical engineers is being enhanced with every graduating class, and for those thinking about becoming a Purdue ME, their future could not be brighter.

■ **William B. White**

Good Vibrations

ME's roving laboratory gives students practical experience.





Mackey Arena had a small structural problem—its floor had a dead area. The flaw was discovered a few years ago by students in ME 497A, “Practical Experiences in Vibrations.” Using a modal sledgehammer and seismic sensors, the students found that the floor’s spring structural design was not uniform, and their findings confirmed what Purdue learned when it repaired the floor of the basketball arena later that year. The students’ work was part of a new approach to learning, introduced by ME professor **Douglas Adams** and his “roving laboratory.”

Adams, who came to Purdue in 2000, first offered ME 497A in the spring of 2003 to 15 students. What makes the course unique is the way that it’s taught. Adams says the course’s design spun out of his own experience. As a student, he constantly critiqued lectures, noting in the margins of his books what worked for him and what didn’t. Being challenged through active learning worked. Being bored didn’t. Doing experiments and then tying them into lectures also worked.

Adams believes that if students are given the opportunity to design, set up, carry out, and interpret their own experiments in structural dynamics, they will learn material more thoroughly than in a lecture environment or a vicariously run laboratory environment. In traditional classrooms, lab experiments are prearranged to reinforce theoretical concepts, and students are rarely asked to engineer their own experiments. Adams’ approach reverses the process.

“When you see the data and then hear the lecture, the light bulbs go on,” he says. “It’s a gratifying way of teaching. The light bulbs are always going on.”

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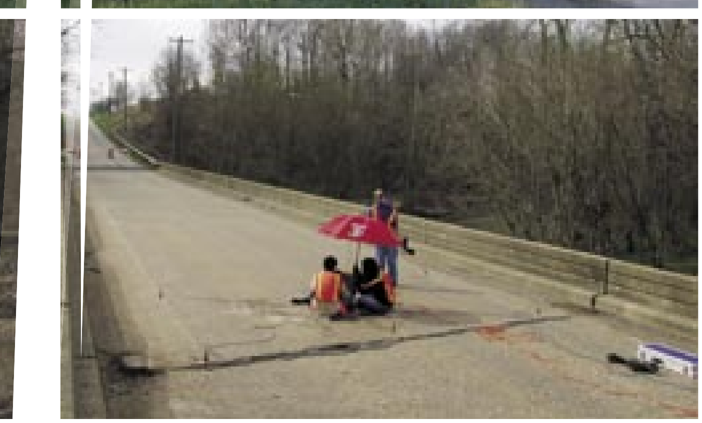
When students take to the field in ME 497A, theory is made real.



Hands-On Approach

Call it collaborative learning, inquiry-based, or experiential, Adams' course is the wave of the future, a teaching method that stresses hands-on experience. The College of Engineering has pledged to move in this direction (see page 12, college side). The National Academy of Engineering says it's a must for the Engineer of 2020. Industry is also on board.

"I work a lot with industry and talk with them about the students they are hiring," Adams says. "They tell me they don't get a lot of people who know how to walk and talk with both the computational and test communities."

And so he prepares his students for both communities. Each spring, 15 or 20 students learn the basic working principles of hardware and software for testing structural dynamic systems. They use products like tennis racquets, baseball bats, golf clubs, a helicopter fuselage, and a remote-controlled vehicle to test basic principles of structural dynamics. Sound fun? It gets better. After time in the lab, the students take to the field in groups with the roving laboratory.

Adams tailors the field projects to group interest; his class draws students from many engineering disciplines:

- Aeronautics and astronautics students tested a model airplane wing to determine at what air speeds the wing would start to flutter, or vibrate, excessively.
- Civil engineering students shut down a bridge over the Wildcat River to test the deck and determine if a composite replacement would be appropriate.
- Mechanical engineering students examined a lathe in the ME machine shop to determine at what point it wouldn't cut in a straight line.

The class is supported by a number of industry partners that furnish equipment. Caterpillar has provided components from large engines for projects in fatigue failure, and the U.S. Coast Guard joined in a project to determine if a KC-130J airplane could be retrofitted with large window panels for search and rescue missions. Students from Aviation Technology built panels replicating the fuselage, which Adams' students then tested for strength and engine noise. Jennifer Daley (BSME '05) was among those who worked on the KC-130J and calls ME 497A one of her top-three college classes.

"The class was different because it relied heavily on experimental methods and analysis to explain the theory taught in class," says Daley, who is a staff engineer with the New Graduate Rotation Program at Solar Turbines in San Diego. "While we talked about the response of a system to certain inputs in class, you could see the response through the results of information gathered through instrumentation." Daley says she has applied what she learned about experimental concepts and testing to her rotation in sustaining design on industrial gas turbine rotordynamics and vibration characteristics.

Brandon Zwink (BSME '05), a graduate student and research assistant in Adams' lab, also worked on the KC-130J. The class spun off into his master's research project, which involves a composite rotor blade for a military helicopter.

"Taking the class gave me an appreciation for the math and dynamics classes I had taken as an undergraduate student," he says. "Many of my undergraduate courses were very theory-based, so the 497A class was a great opportunity to see how the theory can be applied in a real-life application."

An Engaging Subject

Adams, who was named a University Faculty Scholar in January, is animated when he talks about the class. He is eager to share information about it, has volumes of data that tracks student reaction over its five-year life, and is happy to provide a PowerPoint. A poster promoting ME 497A promises fun: "Would you like to know how automobiles respond when we drive over a pothole? How tennis racquets respond when we hit a ball? How bridges and buildings respond during earthquakes?" Even a non-engineer could get interested in that.

For engineering students, though, the course promises control of the learning process; Adams and his graduate assistants serve as "learning coaches" who interact as the students conduct experiments. Adams likens it to the experience he had as a co-op student at the University of Cincinnati with a consulting engineering company.

"My work was not in the lab," he says. "I did data acquisition on the road. It was the best example of apprentice-approach learning that I had seen. My interaction with the professor or mentor in the company was a very good model for pedagogy."

The course breaks ground by teaching theory and practice simultaneously, rather than letting theory guide practice; encouraging lifelong learning; connecting classroom and industry; and promoting curriculum innovation. And it does all that while teaching the fundamentals of mechanical engineering.

"Signal processing, dynamics, measurement analysis...This is one of the courses," says Adams, "that ties it all together."

■ **Linda Thomas Terhune**

How Stuff Works

Today's assignment: disassemble a dead-bolt door lock, learn its mechanical secrets, and put the thing back together again.

Student Eric Lonn co-teaches the course.

As students trickle into Room 116 of the Mechanical Engineering Building on a Monday morning, a plastic bag full of screwdrivers and a big tub full of brass doorknobs greet them. Within minutes, the sound of metal moving on metal—*click-click, click, click-click*—fills the air. At their instructors' urging, the students are taking apart dead-bolt mechanisms—standard door locks, too—and pondering the rarely seen insides: cranks, cam shafts, and springs. By the end of the class, they'll put the door locks back together again.

That's ME 297W, "How Stuff Works," a course funded with gifts from BP. It's the brainchild of Jim Jones, a mechanical engineering professor and associate head of the school. He'd noticed over the years that fewer and fewer students enrolling in mechanical engineering had hands-on experiences coming into Purdue. "We used to have numerous farm kids that regularly worked on their tractors, combines, or cars," he says. "That's not true of most of our students anymore."

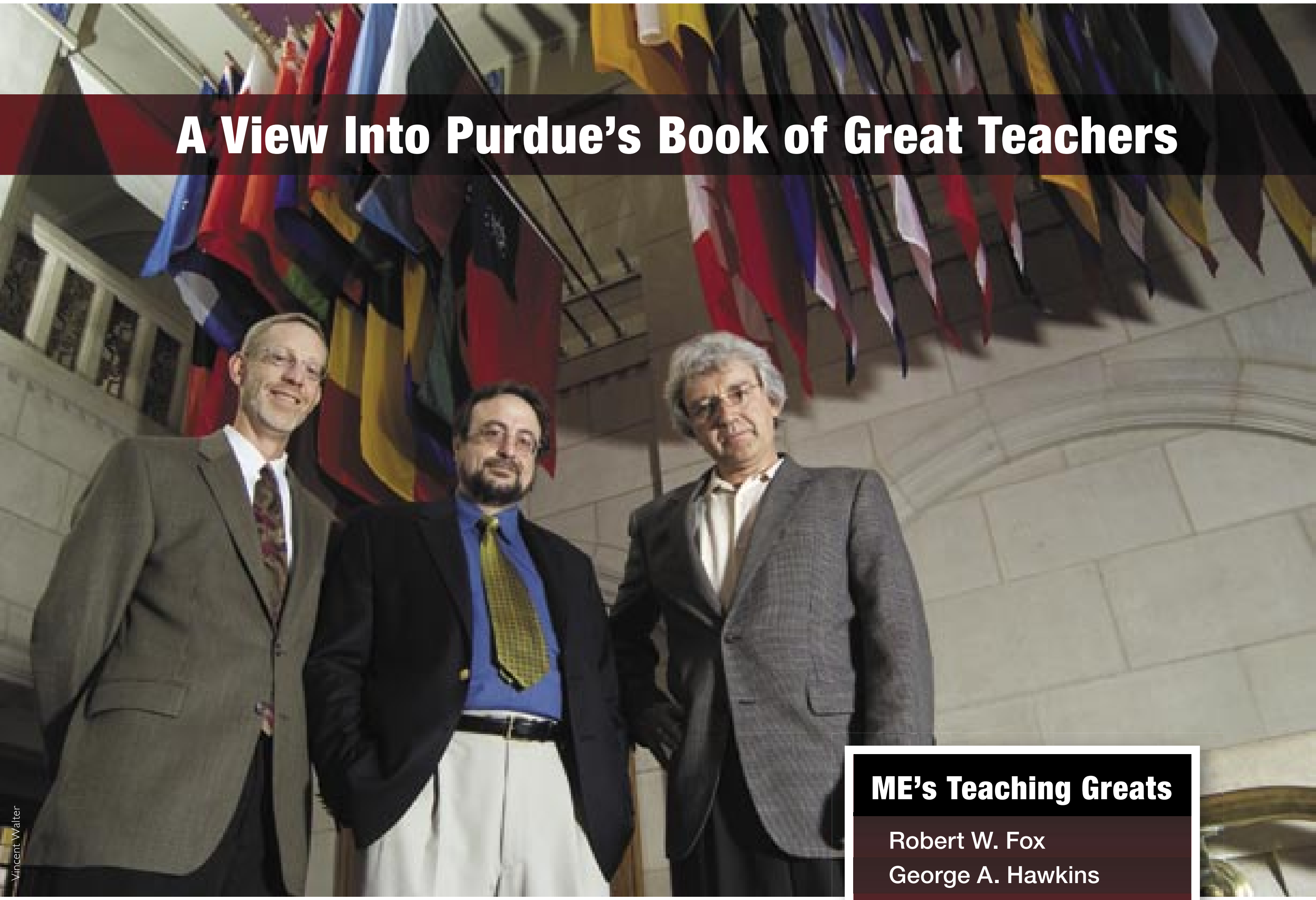
Jones had run across the "How Stuff Works" Web site (see howstuffworks.com), which examines the function and design of everyday items, and the idea for the ME course was born.

ME upperclassmen teach the course. (It was offered for the first time in fall 2006 and is open to engineering and non-engineering students alike.) Besides doorknobs and dead bolts, students have torn apart doorbells, fish tank pumps, and hair dryers—and built a simple electrical circuit. "Students also learn common engineering terminology that faculty often use, like *cams, shafts, rocker arms, pistons, cylinders,* and *coils*," says Jones. The whole experience makes students' other coursework more meaningful because they've seen mechanical parts in use in common household products. The semester wraps up with students each bringing in a mechanical device of their own choosing and demonstrating to the rest of the class how it works.

Participants appreciate the hands-on approach. "The class helped me gain an understanding of how simple devices work and the importance of manufacturing design," said one in a course evaluation. And for another, "taking apart the remote-control plane engine was one of the best parts of the class."

■ **Lisa Hunt Tally**

A View Into Purdue's Book of Great Teachers



Vincent Walter

ME's Teaching Greats

- Robert W. Fox
- George A. Hawkins
- Frank P. Incropera
- James D. Jones
- Charles M. Krousgrill, Jr.
- Issam Mudawar
- Charles W. Rezek
- Harry L. Solberg
- H. Gerald Venemann
- G. A. Young
- Maurice J. Zucrow

Established in 1999, Purdue's Book of Great Teachers honors outstanding teaching faculty who have demonstrated sustained excellence in the classroom. The walnut and bronze plaque, located in the west foyer of the Purdue Memorial Union, originally listed 200 professors from across the university; new names are added every five years.

Candidates must have served on the faculty for at least 10 years, and recipients of the A. A. Potter Best Teacher Award (the College of Engineering's highest honor for teachers) and the Murphy Outstanding Undergraduate Teaching Award (Purdue's highest honor for teachers) are automatically included.

Today, 11 names from the School of Mechanical Engineering (see box) appear on the plaque. At right, a look at the three current ME faculty members who have received this prestigious honor. ■ **Rebecca Goldenberg**

Issam Mudawar: A disciplined approach

"Students are really scared of me on day one," laughs Issam Mudawar, professor of mechanical engineering. His strict teaching methods have helped garner him countless awards since coming to Purdue in 1984, the year he founded and began directing the Boiling and Two-Phase Flow Laboratory and Purdue's International Electronic Cooling Alliance. Since then, he has somehow managed to write nine book chapters, 28 press releases, more than 130 journal articles, and much more.

Mudawar won his Murphy Award in 1997. Student nominations praised the professor's ability to teach the arts of thinking and understanding, though Mudawar maintains that the most difficult concept to teach is time management.

Still, Mudawar loves his job. "Of all the professions out there, I don't think you will find a more honorable profession than being a professor. It's highly selfless in every respect, and you immediately see the impact on the students." ■

Jim Jones: Seeing the whole student

The man who unwittingly wore a dress shoe and a tennis shoe to campus is none other than Jim Jones, associate head and associate professor of mechanical engineering (and sometime absent-minded professor). Primarily concerned with the welfare of his students, he spends his days learning individuals' names and actively engaging students in his Basic Mechanics lectures. This carefully focused attention is what ultimately won him the 1998 Potter Award.

"Intellectual development is a big part of what we do here at Purdue," says Jones, "but I think we also need to have focus on spiritual development, physical development, and all the other aspects because we need to look at students as whole people, not just one-dimensional."

Preparing students for every area of technology is impossible, so Jones always does the best he can to supply the important foundations for further studies and careers after college. ■

Charles Krousgrill: Journeying through fundamentals

Charles Krousgrill, professor of mechanical engineering and academic director for engineering professional education, focuses on the voyage rather than the destination. "The hard part," he says, "is getting students to think in terms of the fundamental ideas rather than how to get the right answer."

Krousgrill, a three-time Potter recipient, is currently working within a team of four mechanical engineering professors to instruct "Engineering Disasters." The new course teaches sophomores to examine past disasters (the Tacoma Narrows Bridge, the space shuttles Challenger and Columbia, etc.) and, where possible, discover the origins of these mistakes. "Our goal is to have students think about these things now so that when they're put in a position where they have to make a hard call, they can do it," Krousgrill says.

The course is ultimately designed to make students aware of the consequences of their actions. In a world brimming with politics, red tape, and budget cuts, learning to make the hard call—the right call—is priceless. ■

Senior Design Goes Global

A student-designed solar oven may help Tanzanians.


Jeff Velker, Purdue BSME 07, explaining the operation of a South African solar oven.

In Tanzania, cooking *ugali*, a thick maize porridge seasoned with spinach or beet sauce, begins with a long trek for increasingly scarce firewood. Today, meals in Tanzania, which has lost 15 percent of its forest cover annually for the last decade, are cooked less frequently and drinking water no longer boiled.

Even with sufficient supplies, wood fires cause severe respiratory problems for people already challenged by poverty, malnutrition, and a life expectancy of just 49.

Help may come, thanks to a solar oven created by a Purdue University class.

Challenging design constraints

The portable oven, measuring two feet by one foot by one foot when folded, weighs 36 pounds and can heat to 270 degrees Fahrenheit. It holds two pots—one for *ugali*, the other for sauce. Most important, it likely can be manufactured in Tanzania for less than $30.

"The project intrigued me," says Matt Carroll (BSME '07). "I enjoyed my heat and mass transfer class, and, in essence, this is a massive heat and mass transfer problem. It's a simple design, with no moving parts. The pots sit on a wire rack, and you close the lid to cook."

Fellow team member Jeff Velker (BSME '07) says, "It was a good chance to help people. I was inspired to do that. Plus, it was pretty challenging." They were assisted by Josh Cammack, Sam Ludwig, and Pat McCabe, all 2007 graduates.

The results came close to the requirements set by Michigan-based Solar Circle, a nonprofit organization working to establish solar cooking options in Tanzania. It has been seeking a design that could heat to 300 degrees, be light enough to carry on a bicycle, be durable enough to last 10 years, and cost less than $30.

"We are currently building some solar ovens in Tanzania for about $50 each," says Solar Circle president Judy Martin. "This price is too high, making the ovens non-affordable."

Purdue oven chosen for further testing

The Purdue design—one of seven presented in Tanzania in September 2007 and one of three chosen for evaluation—improves on the current Solar Circle oven because it holds two rather than one pot and reaches a higher temperature, Martin says.

Student work on the oven began in a spring 2007 senior design class, which regularly tackles model-to-prototype projects. This one was supported by a seed grant from the Shell Oil Company.

"As part of our work with universities, we have what we call our social investment funding," says Houston Brown, Shell Oil Company's manager of graduate recruitment and university relations for the Americas.

"Shell does this to get students into more hands-on projects, which have a customer that directly receives the benefits of the project," Brown says. "This gets engineers to think about modeling early, understanding customer requirements, and finishing something tangible in a given amount of time. The Shell humanitarian projects have a direct human component, something which we feel to be very important."

Two classes worked on it

The design created by the spring class was handed over to the summer class, whose redesign worked well and met most of the criteria.

"The students embraced this," says E. Dan Hirleman, the William E. and Florence E. Perry Head of the School of Mechanical Engineering and interim director of the Global Engineering Program, who teaches the senior design class.

"They did a good job of recognizing that a solar oven you would build for camping in the U.S. would be totally different than one for Tanzania," he says. "They included a variety of global factors in their final design—local

Matt Carroll, now an engineer with Nooter/Ericksen, describes the design of the Purdue Solar Oven.

materials, how the oven would be used and transported there—and they made design decisions that included cross-cultural considerations, an important aspect in becoming a global engineer."

The team had members specializing in radiation heat transfer, computational fluids, sensors, and materials and manufacturing processes, Hirleman says. "Some unique aspects were the use of recycled lithographic newspaper printing plates for the solar reflectors, the polishing method they developed for those plates, the design of hinges from recycled nails and metals that could be routinely manufactured in Tanzania, and recycled tennis shoe rubber for seals."

Multiple lessons for students

"We think it's a good engineering design," says Velker, one of the students. "The hardest part was knowing how much the materials would cost and what their availability would be in Africa."

Thanks to funding from Ken Decker (BSME '64), a semiretired patent attorney who has volunteered in Liberia and seen the effects of poverty firsthand, Velker and Carroll were able to travel with Hirleman to Tanzania. Both volunteered for the post-graduation trip.

For Carroll, it was his first travel outside the U.S., other than a brief visit to Niagara Falls. "It's nice to get a taste of other cultures," he says. "It's exciting in a lot of different aspects."

While Velker has been to several other countries, "I'm trying to see all kinds of different places," he says. He's interested in working and volunteering outside the U.S. And the design work itself was a learning opportunity, he says. "I feel like now I could be given a project without background information and I could figure out how to do it. After a week or so of research, we were pretty much ready to use our knowledge on this project."

The team presented its design at the Solar Oven Technologies workshop in Morogoro attended by representatives from government, private industry, and universities.

"This is something that can make a difference," says Decker, who provided the student travel funds. "In Liberia, they use charcoal, and face similar problems from pollution and smoke. I'm hoping it might work for that country, too."

The design was well received at the workshop and is now under further study, Hirleman says.

Agri-food specialist Linus Gedi at the Small Industries Development Organization of Tanzania gave it a positive review: "I was pleased to see the Purdue students included economic and cultural factors in their design to the extent that their concepts will be quite helpful in building a set of new microenterprises." ■ **Kathy Mayer**

ASME Achievements

Success! Purdue's student chapter of the American Society of Mechanical Engineers has had several outstanding achievements in the past year. Placing first in district competitions above 20 other universities is by far the students' biggest triumph. They also won third place in the Rube Goldberg Machine Contest with an Indiana Jones–themed juicing contraption and sacrificial orange. In the 2007 Grand Prix race they finished a respectable seventh. The list of successes continues, both for the group and the individual members.

If you lead, you will achieve. President Dan Hursh has implemented plans to increase leadership, a quality he believes is the key to the organization's future success. This semester, he doubled the number of chair positions and created four new committees to actively involve the chapter's 100 members. "As we globalize more and more, we can send students to technical and international ASME seminars," Hursh says. Travel and academic funding from scholarships serves to increase participation and raises the society's chances of success in competitions. It's a win-win situation.

Speaking of symbiotic relationships... In the community, the ASME "Ask ME Program" is thriving. Established last year, members tutor local high school students in math and science subjects. Spurring interest in engineering at Purdue is just one of the many ways that ASME gives back to the supportive School of Mechanical Engineering. "We'd really like to thank ME, our company sponsors, and of course the leadership and dedication of the ASME members," Hursh says, "Without them, none of this would be possible."

■ **Rebecca Goldenberg**

Congratulations to Our 2007 Outstanding Mechanical Engineers

These seven alumni, honored at an October 4 ceremony, have distinguished themselves in fields including manufacturing, fuel cell technology, electronics R&D, management, automotive powertrains, aerospace, and nuclear energy.

Purdue's 2007 OMEs (from left): Savino, Zmola, Pertz, Bronson, Elter, and Rankin (not shown: Kim).

Henry D. Bronson

BSME '57
Chairman
U.S.A. Drives, Inc.
Oak Brook, Illinois

"Graduating in 1957 coincided with Russia's launch of the first earth satellite. The next decade of engineering culminated with classmate (in descriptive geometry) Neil Armstrong's first 'small step' on the moon. Now, Mechanical Engineering is challenged to intelligently, effectively, and efficiently utilize our energy resources."

John F. Elter

BSME '64
Chief Technology Officer
Plug Power, Inc.
East Greenbush, New York

"My Purdue mechanical engineering degree has had an immeasurable impact on my life. As the first person in my family to graduate from college, it has enabled me to achieve the dreams and aspirations of my parents and grandparents. It has also enabled me to pursue sustainable approaches in the development of high-technology systems.

"Engineering has always had a special place in my heart, for it represents the means by which society can achieve its goals and its responsibilities of providing a sustainable life for all living creatures."

Douglas A. Pertz

BSME '75
Partner
One Equity Partners, LLC
Lake Forest, Illinois

"Purdue University provided me with the educational, ethical, and critical-thinking skills that shaped my approach to problem-solving throughout my professional and personal life. As a third-generation Purdue engineer, I am grateful for the strong foundation that has supported my goals and career development."

Robert W. Rankin

BSME '72, MSME '73
Retired Chief Powertrain Engineer
Ford Motor Company
Bellaire, Michigan

"As I moved into the management phase of my career, I learned the power and excitement of leveraging the 'team' through creative thinking, focusing on real issues, and solving real problems. Some of the most important traits that I have witnessed in successful people are their sense of mission, drive for accomplishment, and excitement.

"I was very fortunate to have mentors at Purdue and Ford who had these traits and inspired others with their passion for engineering excellence."

Joseph M. Savino

BSME '52, MSME '53, PhD '55
Retired Aerospace Engineer
John H. Glenn Research Center at Lewis Field
National Aeronautics and Space Administration
Cleveland, Ohio

"An engineering education elevates the scope and value of life experiences. It thereby provides the engineer with infinite opportunities to be creative, contribute to society, and achieve personal satisfaction. Nothing is more rewarding than to be recognized for new and significant creations."

Paul C. Zmola

BSME '44, MSME '47, PhD '50
Principal
C&P Engineering
Chevy Chase, Maryland

"The late Dr. A. A. Potter, past dean of engineering and sometime acting president of Purdue University, was fond of identifying the requisite characteristics of an engineer as having **'**a keen analytical mind and a command of the mother tongue.**'**

"Experience reinforces the overarching importance of analysis and communication. As engineers, we recognize their importance as applied to technology and associated business economics in the development of any project, system, or product. Sometimes neglected are maintenance, the environmental impact, ecology, politics, and public perception. Ignoring any of these areas is done at peril to any project." ■

First BSME/MBA graduate: **Sandy Lukito Tanudirjo** (near right) stands with ME professor **Jim Jones** at spring commencement. Tanudirjo is the first to complete Purdue's BSME/MBA program.

Class Notes

William G. Agnew (BSME '48, MSME '50, PhD '52): Retired from General Motors in 1989. Active on the Engineering Advisory Board of Oakland University, visiting professor at the University of New Mexico, NAE member, member of the Report Review Committee for NRC, organizer of the Intelligent Ground Vehicle Competition, originator of SAE's interactive educational program "A World in Motion."

Douglas Duesing (BSME '00): Currently working as a regional sales engineer for Greene, Tweed & Company in Houston, Texas. Was recently married to Amy on June 30, 2007.

Richard Erth (MSME '66, PhD '70): Retired from Mine Safety Appliances Co. in Pittsburgh. Appointed by NIST to the 2007 Board of Examiners for the Malcolm Baldrige National Quality Award, the highest level of national recognition for performance excellence that a U.S. organization can receive.

Ben Furnish (BSME '00): Married Mindy Snyder in 2005, new addition to the family in August 2007; currently attending University of Pittsburgh for MBA, currently webmaster for the Purdue Club of Pittsburgh, member of Pittsburgh Product Strategy network and member of the American Marketing Association.

John Harmon (BSME '48): Received a Distinguished 50-Year Member Award from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Currently serves as president of John J. Harmon Consulting Engineering in Richmond, Virginia.

Adam Randall (BSME '00): Recently returned to Merck as a sourcing manager after spending two years on the sales side with a small technology company.

Normand C. Smith (BSME '58, MSME '61): Retired from IBM as manager of development; member of Pi Tau Sigma.

Kyle Thomas (BSME '05): Currently working as a project engineer in the Knee Research and Development Department of DePuy Orthopaedics in Warsaw, Indiana.

Ashwin Varadarajan (BSME '06): Currently working as an associate fabrication engineer in the Dry-Etch Engineering Department of Micron Technology in Manassas, Virginia.

From Heavilon Hall to the Gatewood Wing

ME looks forward to innovative new space.

When I am asked about the impact of The Campaign for Purdue on the School of Mechanical Engineering, the first thing that pops into my mind is the Roger B. Gatewood Wing. The campaign made this nearly 80-year vision possible!

The 1928 Campus Master Plan showed the Gatewood Wing even though that was many years before Roger was even born. A rendering of the Gatewood Wing was published in the alumni magazine in 1948 (Roger was toddling around by then), and I recognized the need for the additional space and renovated labs when I was a freshman in 1960.

We'll be adding approximately 41,000 square feet of student learning space (classrooms and laboratories), research laboratories, and common areas and offices. When asked about the impact of the Gatewood Wing on students, Gabriela Torres (BSME '07) said, "It will be fantastic when it is finished. We don't have enough large classrooms; our labs are old and way too small, and the common areas where students can work together just don't exist in the ME Building today."

As Torres says, our facilities are old and well-worn. Thousands of students passing through the doors tens of millions of times over the years have taken a toll on our facilities, and having to "force fit" people, equipment, and projects into inadequate space makes it worse.

Our students spend a lot of their waking (and maybe a few sleeping) hours in the ME Building. It's their home away from home. Depending upon their classes and extracurricular activities, students will spend from 30 to as many as 70 or 80 hours a week in this building. That is why our goal is to provide facilities that make our students as comfortable here as they would be in their residence. We are striving for what we call a "Residential Campus."

Even though we want our new facilities to be state-of-the-art and feel residential, we also want the new facilities to reflect our heritage and history. The Gatewood Wing will be state-of-the-art and "residential" with the Yu Global Design Studio, the Cordier Collaboration Room, the Perella Biomechanics Laboratory, the Brown Flexible Multimedia Classroom, the Orth Undergraduate Student Commons, and the Wilson Graduate Student Commons.

David Umberger

Roger B. Gatewood receives the Crystal Boilermaker from Purdue President France A. Córdova during the October celebration of ME's planned Gatewood Wing.

The first engineering laboratory at Purdue was Heavilon Hall, dedicated on January 19, 1894, but it was consumed by fire on January 23, 1894. President Smart said, "It shall be rebuilt, and the tower shall be one brick higher." It was rebuilt (actually nine bricks higher) and was the Mechanical Engineering Building until renamed Heavilon Hall in 1930. That building was razed in 1956, but the clock was placed in storage, and in the 1990s it was restored by Professor John Fessler. That century-old mechanical clock will be in the Hollander Atrium as a reminder of our history and heritage.

The Gatewood Wing has been a long time coming, but there is now light at the end of the tunnel thanks to those who supported the campaign. Without the support of our alumni, friends, and corporate partners, we could not have celebrated our campaign success on October 25.

But the Campaign has meant more than the Gatewood Wing. Our focus is student learning and the discovery of new knowledge, and those take more than buildings. They take the best students and the best faculty.

The campaign meant millions in scholarships to make a Purdue mechanical engineering education accessible to the brightest students. Without financial assistance, many students might have had a lesser educational experience or no higher education at all.

The Campaign has resulted in nine new endowed professorships, giving Purdue's School of Mechanical Engineering the opportunity to attract and retain top faculty. The best faculty brings with it the discovery of new knowledge that creates new businesses and jobs. The best students, learning with the best faculty, yield the best engineers—and that is our bottom line. ■ **Keith Hawks**

Hawks is assistant head and associate professor of mechanical engineering.

Coming Up: Spring 2007

February

22	National Engineers Week: Distinguished Engineering Alumni Convocation
23	Rube Goldberg Machine Contest (local)
29	Boilermaker Ball, Union Station, Indianapolis

April

11-13	Spring Fest/Gala Weekend

Solution to the Fastball Puzzle

Here's the puzzle as presented in the Summer 2007 issue of *Mechanical Engineering Impact*:

During the seventh inning, National League Cy Young Winner Randy Johnson throws his "killer fastball" and hits a 5.5-oz. dove. The ball and the dove stick together after the impact. Taking the point on the ground directly under the collision as the origin, the dove moves in the xz plane, and its motion is given by z = 3⁄4(x+1)^2 + 5/4. At the point of collision, the speed of the dove is 10 mph, and the speed of the ball is 95 mph in the positive y direction. Neglecting air friction, where do the ball and dove land? Assume the ball weighs 0.328 lb.

And here's the solution:

- Solve for slope of velocity vector, V_{dove}:
  - $z = \frac{3}{4}(x+1)^2 + \frac{5}{4}$
  - $z' = \frac{3}{2}(x+1) = \frac{3}{2} \cdot x + \frac{3}{2}$
  - Plug in point (0,0,2): $z' = \frac{3}{2} \cdot x + \frac{3}{2} = \frac{3}{2}$
- Break the velocity vector into components:
  - $\theta = \text{atan}\left(\frac{3}{2}\right) = 56.3°$
  - X: $V_{dove}\cdot\cos(\theta)(-\hat{i}) = -10\left(\frac{5280}{3600}\right)\cdot\cos(56.3) = -8.14\hat{i}\ ft/sec$
  - Y: $V_{dove}\cdot\sin(\theta)(-\hat{k}) = -10\left(\frac{5280}{3600}\right)\cdot\sin(56.3) = -12.2\hat{k}\ ft/sec$
- Find velocity vector, V_{ball}:
  - $V_{ball} = 95\left(\frac{5280}{3600}\right) = 139.3\hat{j}\ ft/sec$
- Use conservation of linear momentum to solve for initial velocity of combined system:
  - X: $V_{1,combined} = M_{dove}V_{1,dove}/(M_{dove} + M_{ball}) = \frac{0.344\cdot(-8.14)}{0.344+0.328} = -4.16\hat{i}\ ft/sec$
  - Y: $V_{1,combined} = M_{ball}V_{ball}/(M_{dove} + M_{ball}) = \frac{0.328\cdot(139.3)}{0.344+0.328} = 68.0\hat{j}\ ft/sec$
  - Z: $V_{1,combined} = M_{dove}V_{1,dove}/(M_{dove} + M_{ball}) = \frac{0.344\cdot(-12.2)}{0.344+0.328} = -6.25\hat{k}\ ft/sec$
  - Note: 5.5 oz = 0.344 lb
- Solve for time in air:
  - $0 = 2 - 6.25 \cdot t - \frac{1}{2} \cdot 32.2 \cdot t^2 \rightarrow t = -0.596,\ 0.208\ sec$
- Solve for distance traveled in X and Y directions:
  - $x = -14.2\ ft/sec \cdot 0.208 sec = -.866\ ft$
  - $y = 68.0 ft/sec \cdot 0.208 sec = 14.2\ ft$
- Therefore the ball and bird land at (-0.866, 14.2, 0) ft.

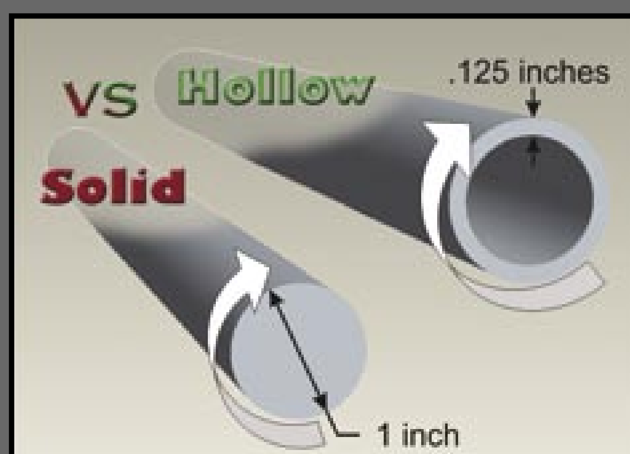
Congratulations to two readers who submitted correct solutions: **David W. Hanna** (BSME '58) and **Carl Johnson** (PhD '69)

New Puzzle!

Torque Troubles

An enthusiastic engineer working for a race team overheard a rival discussing how important it is to reduce "rotating mass" in order to get quicker vehicle response. To impress his chief engineer, he redesigned the half-shafts from 1-inch solid shafts to hollow shafts using the same material, while not changing the length or the amount of torque it will transmit. He carefully matched the max shear stress in the new shaft to determine its diameters and chose a wall thickness of 0.125 inches to prevent accidental damage. A week later the half-shafts had been machined and returned. What is the new mass and mass moment of inertia compared to the original? Express the two answers as ratios, new/old. Do you find anything interesting? Consider what other information would be required to actually determine if his effort was worthwhile.

Assume: loading is pure torsion, and shafts are perfect cylinders with no splines.



Puzzle supplied by Purdue's Formula SAE club.

aperture

This is an image of a quantum dot produced by a simulation using the nanoHUB, a Web site created by the Purdue-based Network for Computational Nanotechnology. NanoHUB is used by more than 3,000 national and international researchers and educators each month. This image shows the computed second excited electron state of a quantum dot nanodevice in which electrons resonate and emit pure bright light. Quantum dots are the basis of the new, energy-efficient, long-lasting, ultrabright light-emitting diodes (LEDs) that are becoming widely used in highway traffic signals.