

Fall 2000

## Dimensions Fall 2000

Iowa State University Department of Mechanical Engineering

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# UPDATE

## Mechanical Engineering

FALL 2000 • VOLUME 10, NUMBER 2 IOWA STATE UNIVERSITY

### Global warming: Building better stoves



ME Assistant Professor Mark Bryden and a student test and model various types of stoves.

**G**athering together a few small sticks, ME Assistant Professor **Mark Bryden** places the bundle inside some metal tubing attached to a 1996 Super Bowl popcorn tin. He strikes a match igniting the wood, and an orange glow begins growing inside the tin. Flames flicker out of a hole cut in its top. Bryden places a small pot of water over the hole and soon the water begins boiling.

Bryden isn't surprised by this small success; he expected it. Bryden's specialty is analyzing biomass-burning stoves to create mathematical models of how well they work and suggest improvements. His research will help improve the lives of people living in Third World countries, where wood stoves occupy a critical place in everyday life.

According to Bryden, between two and three billion people worldwide use biomass-burning stoves to meet their daily energy needs. Yet these stoves are notoriously inefficient and sometimes dangerous. Wood-fueled open fires can cause smoke damage to the eyes as well as acute respiratory infections, which play a large part in infant mortality.

Last September, Bryden traveled to Cottage Grove, Oregon, to conduct research at the Aprovecho Research Center. Staff at Aprovecho (Spanish for "I make the best use of") study and teach elements of eco-centered


lifestyles, and one of the group's missions is to improve life in the Third World. While at Aprovecho, he analyzed stoves collected by the group, spending his nights in the upscale confines of a nearby monastery.

Back at his biomass laboratory at Iowa State, Bryden studied stoves ranging from configurations of tin cans to one made out of clay and donkey dung. Then, in March, Bryden and his 16-year-old son, Ben, traveled to Nicaragua with members of Aprovecho. There, they worked out of a trash dump in a Nicaraguan barrio or slum, Bryden studying stoves and his son serving as translator. It was Bryden's first trip to the country and he said it had a definite impact on him.

"About 83 percent of Nicaraguans in urban areas use wood for energy, and the figure is 97 percent in rural areas, so wood is a very important commodity," said Bryden. "Any ability to increase efficiency will not only save money but also reduce pollution and ill effects on health."

An open fire, Bryden said, is about 10 percent to 15 percent efficient. Many advanced Third World stoves are 20 percent efficient. Through tests in the field and at his lab, Bryden is trying to bring that efficiency up to 30 percent or more. A more efficient stove will also be less costly to use. Most Nicaraguans earn about \$20 a month but it costs 50 cents to \$1 a day to meet a family's energy needs. Bryden hopes that using a more efficient wood-burning stove would cut costs by up to 50 percent.

Bryden and Aprovecho hope to procure funding in order to manufacture and distribute fuel-efficient stoves in Nicaragua and elsewhere; but, as Bryden said, "it's hard to get money for research to help poor people."

Next, Bryden plans to present a paper at the International Stoves Conference in Pune, India, in mid-November. He also hopes to travel to Guatemala to study stove efficiency for another group. 

# Notes from the Chair

**A**BET has been a continuing story, at least for the last two issues of ME Update. In mid-July the Department prepared out self-study, that provides our ME program objectives, the curriculum to achieve these objectives and the process we use to develop and improve them, plus information on our students, faculty and staff, finances and facilities. In mid-September, the team from the Accreditation Board for Engineering and Technology (ABET) spent a very busy two and half days on campus to see do the “face-to-face” things like visiting classes, one-on-one visits with students, faculty and staff, as well as see instructional labs and other facilities in the Department. The official word will not come back to us until July of 2001, but the unofficial word was very positive and we expect a positive accreditation recommendation next summer. This was a successful team effort, but it is also a continuing effort of assessment and improvement. A number of you as alumni may directly become part of our assessment and improvement process. The Department has committed to developing an alumni survey of graduates, initially probably those 3 to 5 years out, on how your ISU mechanical engineering education prepared you for professional practice. We really will need your time and honest evaluation to complete and return our survey as part of our continuous improvement process.



The job market for all engineers continues to be excellent. For ISU mechanical engineering graduates, in addition to the many long-standing and valued employers, the chemical and process industries, biomedical manufacturing, electronics, and automation sectors, as well as firms that provide general consulting services and – believe it or not – investment banking, are after our graduates. This external environment and the quality of our program and faculty is evident in the nearly 8% increase in mechanical engineering enrollment over last year. This means over 900 ME undergraduates, and for the third year in a row the ME Program is the largest in the College of Engineering and second largest - after business - at Iowa State. Big is one thing, but what about quality? The data we have is that has really not changed, we still have an average ACT score of 27 for first-year students; that's great! It is this group of fine students and support from alumni and friends of the Department who

have made it possible for nearly 160 ME undergraduates to receive over a quarter million in scholarships in Fall 2000. Both the number and average amount of scholarships have increased in the past four years, and I hope the trend will continue because I know the need will. Our students are also competitive when applying for external scholarship awards. For example, at the Society of Women Engineers annual meeting, Amber Hasche, a first year student was awarded a Daimler-Chrysler Corporation Scholarship and Sibil Joseph, a junior, received a General Motors Foundation Scholarship. Two of our students received 3 scholarships from ASME. Ashlee Schmidt and Alan Tkaczyk both received an ASME Central Iowa Section Scholarship, and Alan Tkaczyk (last month's ME Update had Alan's picture where he was identified as a ceramic engineer – he is - but is double major and is also an ME) also received the national John & Elsa Gracik Scholarship from ASME's Council on Education.

And what about those who have gone before? I was pleased to receive a note and copy of a special publication entitled 100 Most Influential People of the Petroleum Century, with pictures of Henry Ford and John D. Rockefeller, Sr. on the cover. Inside, recognized for his pioneering work in horizontal drilling, was Dr. Sadanand Joshi, who received his Ph.D. from the Department in 1980. Dr. Joshi continues his active contributions to this industry as president of Joshi Technologies International, Inc. in Tulsa. John and Jeanette McKiernan stopped in my office this summer while on the way to John's 60<sup>th</sup> high school reunion. John received his Masters in Mechanical Engineering in 1949 when Henry Black was Head of Mechanical Engineering. John is retired now, but spent a long and distinguished career at Sandia National Labs in Albuquerque, while at the same time being active in ASME as a Vice President for Region 12 and later as a member of the first class of ASME Governors.

Again, my space is pretty well used up. In the rest of this issue, you'll learn about another alum Albert Hsu, new faces on the faculty, and a historic event on campus - decommissioning of UTR-10.

*Warren R. DeVin*

## Reactor is demolished

**O**n a hot summer's day in July, a concrete structure that once defined nuclear engineering at Iowa State was finally laid to rest. As handrails, conduits, and concrete shields all came down, the nuclear reactor facility in the three-story atrium of the Nuclear Engineering Building (formerly Chemical Engineering West) was demolished and its concrete remains hauled away for safe disposal.

"Decommissioning nuclear reactors is a necessary process that takes place after a facility has outgrown its usefulness," said Associate Scientist and former reactor manager **Scott Wendt**. Declining enrollment led to the closing of the nuclear engineering program in 1996, at which time, supported by funds from the College of Engineering and the university, the decommissioning process was set into motion.



*The nuclear reactor was demolished last summer; its remains were hauled to a disposal site in the South.*

Shutting down and dismantling a nuclear reactor entails stringent compliance of guidelines set by the Nuclear Regulatory Commission. The process begins, said Wendt, by first expressing to NRC an intent to shut down, which is followed by a site characterization that quantifies radiation levels. Next, a report is submitted to the NRC, detailing all aspects of decommissioning, from operator training, safety issues, and demolition steps to cleanup, final survey, and cost. Decommissioning begins only after these detailed safety and health plans are reviewed and approved.

Nuclear fuel in the form of radioactive uranium was disposed of in two stages. In 1998, 3.3 kilograms was shipped to a U.S. Department of Energy storage facility in South Carolina. When the remaining fuel left the facility in January 2000, the reactor was ready for decommissioning.



*Mark Granus, left, project manager with Duke Engineering Services, and Scott Wendt, former reactor manager, stand in the cavity of the reactor core.*

The demolition contract was awarded to Duke Engineering Services, a Massachusetts-based company that worked with subcontractors, occupational safety personnel, and radiation specialists, who constantly monitored air quality and contamination levels in construction debris. Special filters were installed to collect contaminated particles that might escape, and each day samples of the concrete leaving the site were thoroughly tested for safety levels.

The demolition process was completed in August with a confirmatory survey and final inspection by the NRC in September. Iowa State submitted a 170-page final report in early October and now waits for the NRC to issue an order terminating the reactor license.

"This order will come only after the NRC has reviewed the final report and other supporting documentation, which may take as long as two years," said Wendt.

## Reactor history

Built in 1959, the 10,000-watt-capacity facility was the initiative of Anson Marston Distinguished Professor **Glenn Murphy**. It was built at a time when Iowa State had the distinction of being one of very few graduate nuclear engineering programs in the nation. The reactor was used solely for teaching and research to understand the principles

*continued on page 4: Reactor comes down*

of nuclear reactors and radioactive materials.

“The nuclear reactor was an important part of lab experiments, giving students a good start in learning the intricacies of nuclear plant management and operation,” said Richard Hendrickson, emeritus professor of nuclear engineering and former reactor supervisor.

“As the nuclear engineering program became less popular, the need for the program declined,” Hendricksen continued. “But experiments conducted at that time considerably enhanced the knowledge of many people.”

Graduates of the program included Edward Walsh, emeritus president of the University of Limerick, and also **Don Glower**, a retired vice president at Ohio State University.


The first of its size and type built in the United States, the Argonaut reactor was designed at Argonne National Laboratory. The Iowa State version was unique in having a large chamber where equipment could be placed to study the effect of radiation on different materials. It also had a large tank on one side to study the effectiveness of shielding materials. A 7-foot graphite column was used to study neutron theory.

**Don Roberts**, retired professor of nuclear engineering who taught nuclear engineering principles to students, recalls one of many significant contributions of the facility. The Navy used the facility during summer instruction programs to learn more about a technology that came to power submarines and ships it uses today, he said. Once the Navy built its own facilities, its use for the Iowa State reactor ceased. The ISU reactor, in a sense, represented “a major breakthrough in putting science in the public domain,” said Roberts.

Although the reactor had a 10-kilowatt capacity, Roberts said it would normally operate at only about 1 watt in experiments that involved understanding fundamental nuclear principles. For example, the pool was used to study how neutrons would slow down when they came into contact with different types of materials. The water in the pool served as a safe barrier to neutron and electromagnetic radiation (gamma and x-rays) but also allowed students to see what they were doing. Using a rod, scientists would lower different materials into the pool and use detectors that gave out electric pulses to measure radiation. Then they analyzed the behavior of the material suspended. “Computers were just coming in, so all calculations involved using the slide rule,” recalled Roberts.

The “training reactor” took textbook knowledge of nuclear science into the realm of practical experimentation. Students learned design and operation of nuclear facilities, fundamental properties of nuclear fission, metals and alloys for use in reactors, shielding devices, purification and fabrication of fuel, disposal of fission products, and application in industrial usage.

### Reactor facts

- First teaching reactor west of the Mississippi
- Occupied nearly 1,000 square feet of floor area
- Nearly 300,000 lbs of concrete were used to contain the radiation produced
- Contained six pounds of uranium, which served as fuel
- Less than one gram of uranium was consumed in over 40 years of operation
- Built by Advanced Technology Laboratories of Mountain View, California, at a cost of \$170,000
- Demolition cost will be approximately \$1,000,000 

# Congratulations Class of 2000



The members of the Class of 2000 were honored last spring at a pre-commencement reception hosted by the mechanical engineering department. Following is a list of the newest ME graduates.

**Brian William Anciaux**  
**Mohd Rapid Arifin**  
**Christopher Michael Barber**  
**Josh Gerald Bauer**  
**Jeffrey Michael Bayliss**  
**Jeffrey Scott Bigelow**  
**Matt Benjamin Birmont**  
**Nathan Alan Bovee\***  
**Michael John Brown**  
**Peter Lawal Brown**  
**Robert Allen Brown**  
**Michael Robert Burns**  
**David Fernandez-Cayon**  
**Brian Christopher Crow**  
**Zachary Joseph DeLong**  
**Jason Eugene Devries\***  
**Dean Mainard Druecker**  
**Matthew Benjamin Dunker**  
**Keith Marvin Fehr**  
**Mitchel Dean Fehr**  
**Justin Edward Fritz**  
**Kristopher Wade Gerber**  
**Rick Walden Goode**  
**Megan Louise Grant**  
**Brandon Michael Grell\***  
**Daniel Lee Hampton**  
**Shane Steven Harrer**  
**David Adam Harrington**  
**Martin James Hefter**  
**Justin Matthew Hekel**  
**William Charles Heuer**  
**Benjamin Richard Hoelsing**  
**Nordica Ann Hudelson\***  
**Amy Karen Huebner**  
**Lucas Evert Huisman**  
**Jason Dirk Jablonski**  
**Judson B. Jones\***  
**Jeremy Allan Kaeding**  
**Thanet Kanlagna**  
**James Willis Kappeler, Jr.\***

**Seth Adam Kranz**  
**Joseph Michael Kuphal\***  
**Tonya Marie Lampe\***  
**Brent Laverne Leistikow\***  
**Craig Alan Lindquist\***  
**Mark Werner Lund**  
**Matthew James McGowan**  
**Adam James Mott**  
**Timothy Joseph O'Malley**  
**Bret Allan Petersen**  
**Tandrea Lea Rayman**  
**Antonio Lewis Reeser\***  
**Anthony Shane Ridgeway\***  
**Robert E. Riedel, Jr.**  
**John Paul Riley**  
**Benjamin Clayton Roberson**  
**Christopher Joseph Roberts**  
**Kyle Glen Roth**  
**Jeffrey Gail Rothermel**  
**Hendry Rustam\***  
**Matthew Philip Sawhill**  
**Erika Rhea Sherer**  
**Bryan Thomas Siegel**  
**Jerrod James Sieverding**  
**Todd Richard Simms**  
**Guy Nathan Smith**  
**David B. Stutzman\***  
**Eric Richard Taylor**  
**Kimberlie Ann Tholen**  
**Richard Cort Tooley, Jr.**  
**Nhon Vinh Truong**  
**Kyle D. Wehring**  
**Cory John Weinberger**  
**Douglas Anders Wibholm**  
**Justin Wilson Wilhelm\***  
**Bret Thomas Winterle\***  
**Timothy James Winters**  
**Likmin Wong**  
**Nor-Zaiazmin Yahaya**  
**Chad Jeffrey Zach\***

\*with distinction

# Your support makes a difference

Generous gifts from ISU ME alums, industry, and others enable our department to continue our tradition of academic excellence. Our ongoing success is linked closely to your contributions, which are used for the following:

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

The Black-Hilstrom Mechanical Engineering Development Fund grew out of a fund started more than 30 years ago by Hollis "Pete" Hilstrom, ME'34. In 1980, Henry Black, department head from 1946 to 1972, joined with Hilstrom to invite other alumni to contribute to the fund. Since then, the endowment has grown to more than \$2 million with gifts from more than 475 alumni.

You can participate in the Black-Hilstrom Fund using the form included here. 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

- To provide support for the Department of Mechanical Engineering, I enclose \$\_\_\_\_\_ by check made payable to the ISU Achievement Foundation and designated to the Black-Hilstrom Fund.
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- I am interested in learning about other ways I can help the Department of Mechanical Engineering.

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Degree(s) \_\_\_\_\_ Year(s) granted \_\_\_\_\_

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

Please return to: The ISU Foundation, Alumni Suite, Memorial Union, 2229 Lincoln Way, Ames, Iowa 50010-7164.

We appreciate your support!

## Blue ribbon baked goods

**Beth Bullen** knows what it takes to win.

Beth, wife of ME Associate Professor **Dan Bullen**, walked away with top honors at the Iowa State Fair's Pride of Iowa Cinnamon Roll Contest. She credits her blue ribbon to the fact that her cinnamon rolls have a few unique touches that makes them stand out from others. Beth's recipe uses mashed potatoes and potato water and features two frostings—one that's almond-based and another made with orange zest.

More than 200 recipes were entered in the competition. Beth and her two youngest daughters attended the judging. She was thrilled when she made the top 10 and literally speechless when she won.

"I couldn't talk," she recalled. "The judges were asking

questions and I couldn't answer—not even easy things like my phone number."

Beth thought about entering the 1999 contest but she missed the deadline. This year's event is the first—and likely, the last—cooking contest she's entered.

"I'm going to quit at the top of my game," she said. "One for one, that's pretty good. I think I'll leave it at that."

The Bullens have four children: Kate, 16; Mark, 14; Sarah, 10; and Rachel, 8. They enjoyed more than their usual share of cinnamon rolls as mom prepared for the contest.

"They've hinted that I should take a bit of a break," she said. "I think they're probably right."

A copy of her award-winning recipe can be found on page 8.


# Department Dynamics

## Praise for Clifford



**Martha Clifford**, secretary to the Mechanical Engineering Advising Center, is the latest recipient of the Superior Service Award presented annually by the Iowa State University Alumni Association. Clifford is usually the first – and sometimes the only person – who needs to handle the questions of undergraduate students or prospective students. There are

hundreds of ISU mechanical engineering students who would have no difficulty defining superior services as it relates to Clifford. A member of the ME department since 1987, she was the first secretary to staff the Advising Center and has been invaluable to increasing retention of first-year students. (ME has one of the best retention records in the College of Engineering.)


Said one of her colleagues: “I believe that Martha Clifford’s superior services to Iowa State is based on a deep commitment to education, our university, and service to the community.” 

## Flugrad honored



**Don Flugrad**, ME associate professor, has been honored by the Iowa State University Alumni Association with a faculty citation for his inspiring service to students, alumni, Iowa State, and his profession. Flugrad is best known for launching ISU’s involvement in a program that department chair **Warren DeVries** calls “the essence of engineering.” The national robot

competition program, called FIRST (For Inspiration and Recognition of Science and Technology), gives high school students – working with a team of practicing engineers and faculty – a chance to experience the excitement, planning, panic, and sense of accomplishment that comes from designing something for a specific purpose, building it, and testing it in competition. Students benefit by experiencing teamwork, and a unique opportunity for diverse groups to work together. The engineering profession benefits by the national recruitment of women and other underrepresented people, who learn that technology and technical people are exciting and stimulating.

Flugrad, who has received formal recognition for his success as a mentor to students and new faculty, is praised by many of his students, one of whom wrote: “Dr. Flugrad is one of those rare people who strikes a natural balance between prodding hard enough to get people thinking, without being overbearing.” 

## Top advisor




**Scott Openshaw** of the ME Advising Center was selected 1999-2000 Advisor of the Year for the College of Engineering. The award was presented by the University Academic Advising Committee. In addition to regular advising duties, Scott works with learning communities and teaches ENGR 170. A display at Memorial Union honored Scott and other top advisors. 

## Outstanding alumnus

**Albert Hsu**, PhDME’95, has received an Outstanding Young Alumnus Award from the Iowa State University Alumni Association. Hsu, of Troy, Michigan, is a senior project manager at Ford Motor Company, where he provides engineering solutions to support Ford design, improve product quality, shorten product delivery time, and reduce costs. Ford has achieved significant competitive advantages with the performance of his systems.

Hsu, who has authored 15 technical papers and reports, has received a number of awards, including the 1998 SME Outstanding Young Manufacturing Engineer Award. He is an SAE paper reviewer as well.

His received honor from ISU was presented at homecoming in October. The award was established in 1968 to recognize ISU alumni under the age of 39 whose achievements in career, public service, and volunteer activities are worthy of recognition and have brought honor to the university. 

## Three join faculty

The newest members of the mechanical engineering faculty are **Li Cao**, **Ted Heindel**, and **Michael Olsen**.



Cao joined the department as an assistant professor this fall after completing her doctoral degree at the University of Minnesota. Her research focuses on design, fabrication, and characterization of implantable drug delivery systems using microelectromechanical systems (MEMS) technology. She has co-authored four articles on the subject. **Cao** is a member of the American Society of Mechanical Engineers (ASME) and the Institute of Electrical and Electronics Engineers (IEEE).

A native of Beijing, China, Cao has been in the U.S. since 1995, when she began work on a second master's and a doctoral degree at the University of Cincinnati. She earned her undergraduate and master's degrees in China, where less than 10 percent of mechanical engineering students are women. Cao was drawn to Iowa State by the balance in teaching and research that the department offers.

Cao's family includes her husband Ziyi Dai, also a native of China, whom she met in the States. They reside in Ames.

Heindel, an associate ME professor, joined the department this fall after six years as an assistant professor of engineering at the Institute of Paper Science and Technology, Atlanta. He received his undergraduate degree from the University of Wisconsin-Madison, and his master's and doctoral degrees from Purdue University. All three degrees are in mechanical engineering with an emphasis in the thermal science area. His current research interests involve transport phenomena in complex fluid systems. These fluid systems are applicable to many process industries including food processing, agricultural waste management, pulp and paper processing, mineral processing, petrochemical refining, and water treatment.

Heindel has co-authored 22 peer-reviewed publications, presented three invited papers, and has contributed chapters to several books. He is a member of the American Society of Mechanical Engineers (ASME), the American Institute of Chemical Engineers (AIChE), Technical Association of the Pulp and Paper Industry (TAPPI), Tau Beta Pi, and Pi Tau Sigma.

Heindel came to Iowa State for its commitment to both teaching and research, and the opportunity to teach at the undergraduate and graduate level. He currently lives in Ames with his wife Mary.



Olsen, an assistant ME professor, joined the mechanical engineering department this fall after two years as a post-doctoral research associate at the Beckman Institute for Advanced Science and Technology in Urbana, Illinois. His post-doctoral research involved developing experimental techniques for studying MEMS systems and investigating chaotic mixing phenomena in microfluidic devices. He received his bachelor's, master's, and doctoral degrees in mechanical engineering from the University of Illinois-Champaign. For his doctoral dissertation, he investigated a turbulent shear flow using particle image velocity. His research interests involve experimental fluid mechanics and heat transfer, the development of microfluidic devices, biological fluid mechanics, and turbulent shear flow.

Olsen has co-authored eight peer-reviewed journal papers and 10 conference papers. He is a member of the American Society of Mechanical Engineers (ASME), the American Physical Society (APS), the American Institute of Aeronautics and Astronautics (AIAA), Tau Beta Pi, and Pi Tau Sigma.



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## ZESTY ORANGE CINNAMON ROLLS

Beth Bullen

2000 Iowa State Fair Champion

Tone's Pride of Iowa Cinnamon Roll Competition

1 package active dry yeast  
1/4 cup warm water  
1 cup potato-cooking water  
1/2 cup mashed potato  
1/2 cup sugar

1 1/2 teaspoons salt  
6 tablespoons butter, softened  
1 egg  
4 to 4 1/2 cups all-purpose flour

Stir the yeast into the warm water in a large mixing bowl, and let stand a few minutes to dissolve. Add the potato water, mashed potato, sugar, salt, butter, and egg, and beat well. Add 2 cups of the flour, and beat until smooth. Add enough of the remaining flour to make a manageable dough, then turn out onto a lightly floured surface and knead for a minute or two. Cover with plastic wrap to prevent drying out. Let rest 10 minutes.

Resume kneading for about 8 to 10 minutes, until the dough is smooth and elastic. Sprinkle on a little more flour as necessary to keep dough from being too sticky. Place in a large greased bowl, cover, and let rise until double in bulk.

Punch dough down. On a floured surface, roll dough into a 14 x 8 inch rectangle. Spread dough with 1/2 cup softened butter. Mix 2/3 cup sugar with 1 Tablespoon Tone's ground cinnamon in a small bowl. Sprinkle over butter. Roll up from long sides like a jelly roll. Cut into 12 equal pieces. Arrange, cut sides up, in a greased 9 x 13 inch pan.

Cover pan loosely with plastic wrap and let rise until doubled in bulk, approximately 30 to 40 minutes. Bake at 350°F for 30 to 40 minutes or until done. Remove from oven and cool on wire racks. Drizzle with both icings one at a time.

Yields: 1 dozen rolls

### Orange Icing

Combine: 1 cup sifted powdered sugar  
1 teaspoon shredding orange peel  
1/2 teaspoon vanilla  
Enough fresh orange juice (1-2 tablespoons) to make icing of drizzling consistency

### White Icing

Combine: 1 cup sifted powdered sugar,  
3/4 teaspoon almond extract  
Enough milk (1-2 tablespoons) to make icing of drizzling consistency

## Department of Mechanical Engineering

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