FSAE: Best Finish Ever!

UW Formula SAE Team 21 entered competition last June with a great car and high hopes. They returned with a $1,750 cash prize and the trophy for third place overall, the highest finish ever for a UW team. More than 50 teams from around the world competed in the FSAE California competition held June 16 to 19 at the Auto Club Speedway in Fontana. The UW placed seventh in the Design competition, eleventh in Skidpad, sixth in Autocross, second in Acceleration (missing first place by 0.01 second), and third in the Business Presentation. Completing the final event, the grueling 22-kilometer endurance event, had caused the most problems for recent UW teams. The diligent checks, careful maintenance, and long hours of training and practice paid off this year with a successful fifth place finish in Endurance. With that finish the car placed second in the Dynamic events and third overall. Congratulations, Team 21!

ME Students Win Innovation Challenge

“To invent, you need a good imagination and a pile of junk,” said Thomas A. Edison. These elements both figured into the development of EnVitrum’s prototype, a living wall made of porous recycled glass, developed by Mechanical Engineering students Renuka Prabhakar and Grant Marchelli. Their invention won the $10,000 Grand Prize in the University of Washington 2010 Environmental Innovation Challenge, and has led to additional honors and awards.

The idea developed out of their work in the Solheim Rapid Prototyping/Rapid Manufacturing Lab codirected by Professors Mark Ganter and Duane Storti. Prabhakar and Marchelli were struck by the fact that only 23% of the glass collected through municipal recycling programs can be reused, with the remaining 77%, or 9.4 million tons, going to landfills. Here was the pile of junk.

“We wanted to find a way to use that 77% to make a useful product so it didn’t just go into landfills,” Prabhakar explained.

In the lab, Marchelli was experimenting with rapid prototyping glass and searching for novel applications. Some of the glass being produced, he noticed, had the ability to wick water by capillary action, an unexpected effect.

As a separate project, Prabhakar had been working on a rooftop garden with the idea of replacing the vegetation footprint eliminated when a building is constructed. Maintaining living roofs is a problem, as water runs down and plants dry out. Then the good imagination came into play. If living roofs could be made of recycled glass that could wick the water up to the plants, the living roofs could be self-sustaining. Prabhakar and Marchelli were aware of the UW Environmental Challenge, and decided to work towards an entry in that competition. Their first challenge was to develop a commercially viable formula and a way to mass produce the wicking glass bricks. After much experimentation, they developed a kiln-fired brick, composed of approximately 95% recycled glass and 5% binding agents.

“‘For the Innovation Challenge, we needed to demonstrate that a wall of our bricks could support plant life by diverting and wicking gray water (essentially any water coming off a building that is not a biohazard) to the plants,” said Marchelli. In nine weeks of long hours and hard work, they moved from concept to a working prototype, a modular system that met their...
HONORS, AWARDS & TRANSITIONS

James J. Riley was a plenary speaker at the American Physical Society Division of Fluid Dynamics conference in California. He also will be a plenary speaker at the ASME/JSME/KSME Joint Fluids Engineering Conference in Japan, in July 2011. He will be a plenary speaker at the American Physical Society Division of Fluid Dynamics conference in California. He also will be a plenary speaker at the ASME/JSME/KSME Joint Fluids Engineering Conference in Japan, in July 2011.

We are working hard to increase the number of undergraduate scholarships and graduate fellowships. They are by far the most important ingredient in the successful recruitment of talented and creative students. We are fortunate to be able to offer scholarships to many undergraduate students due to the great generosity of our alumni and industry partners. Our undergraduate program would not be the same without this wonderful support. It allows us to attract students who otherwise would have gone elsewhere or who would not have been able to pursue a mechanical engineering degree. It is now my goal to replicate this success in graduate fellowships. Every scholarship and fellowship we offer results in the recruitment of a top student and moves us one step closer to our goal of becoming the best ME department at a public university in the country.

Revenue from our research programs has seen impressive growth. Research awards are up 67% since 2006. A highly successful research program benefits everyone. The students get exposure to laboratories and the latest technology developments in a wide range of areas. The department receives more revenue for student and TA support. In addition, the department receives grants for equipment and seed money. These funds are used to support student research, new equipment, and traveling to conferences. The state economy benefits through the graduation of better trained engineers and the creation of more start-up companies, bringing research to the marketplace. Society benefits through advancing the technology base in areas such as medical devices, sustainable energy, and advanced materials.

Our research has increasingly focused on health and energy during the last five years. This focus is consistent with the National Academy of Engineering’s Grand Challenges for Engineering and is moving the department to the next level in national and international stature. This focus has also allowed us to diversify our curriculum with the addition of courses in biomechanics, nanotechnology, cell mechanics, microfluidics, active and sensing materials, microelectromechanical systems, energy conversion and design, design for the environment, and acoustics.

The ME department has been fortunate to hire new junior faculty members of exceptional quality. Since joining the faculty, they have all won prestigious Career Awards from the National Science Foundation and have the potential to become superstars. The younger faculty members are complemented by a world-class senior faculty. The resulting synergy positions the department to limit the size of our department, including the number of undergraduate students, TAs, advisors, and lab support. In addition, our ability to increase the number of undergraduates is further constrained by the comparably small size of our faculty (26 core members). This situation cannot be allowed to continue without a fight.

We are all committed to creating other revenue streams so that we can be independent of changes in state funding. The department needs to grow to allow more students to participate in the world-class ME education they deserve here at UW. The solution requires us to identify non-state revenue sources such as overhead funds from research, for-educational programs, royalties from patents, private gifts, and endowments.
Assistant Professor Jaehyun Chung has been named the recipient of the Bryan T. McMinn Endowed Research Professorship in Mechanical Engineering. This endowed professorship recognizes and supports the research of promising junior faculty. “The research of our junior faculty marks the department’s path to the future,” said Per Reinhall, ME chair. “It is crucial that we recognize and support their efforts. The McMinn Endowed Chair is an important way we do this.”

The McMinn Endowed Professorship was established in 2006. In that year, an estate gift from Richard and Janice Odell in memory of her brother, Bryan McMinn, was augmented by department discretionary funds to create the endowed chair. The endowment provides an annual sum which the chairholder may use to further his or her research.

Professor Chung’s research field is nanoeengineer-

ing for low-cost, rapid diagnosis of infectious dis-

eases. Low-cost diagnosis is challenging, because disease screening or profiling must be conducted using simple operations that do not compromise the performance of laboratory devices. By using nanostructures, toxins and pathogens can be con-

centrated and detected with high sensitivity and specif-

icity. Chung’s research holds great prom-

ise, employing advanced technology to develop inexpensive devices that could help save countless lives in poor and underdeveloped countries.

“It is a great honor to receive the McMinn Profes-

sorship,” said Chung. He plans to use this funding to enhance research efficiency by filling the gap between initial ideas and preliminary results, pur-

chasing materials for undergraduate education, and as matching funds to purchase equipment for the ME department and his laboratory. “This funding will provide crucial support to allow me to develop new ideas and innovations to the point where outside funding can be pursued,” he said.

Kipple Scholarship Plans Accelerated

William “Bill” Kipple put himself through the university by work-

ing in the building trades during the depression and at Boeing throughout World War II. He completed a bachelor’s degree in mechanical engineering in 1946. Later that year, Bill met Dorothy at Mt. Rainier, where both happened to be taking a short vacation. Their courtship was also short, as they married ten weeks later.

After the war Bill started a building and contracting business for residential homes and commercial space in the Seattle Metro area. Until he retired and closed the company in 1983, Bill considered himself a hands-on craftsman who found joy in working with tools and seeing the products of his labor.

Dorothy worked for Dr. Ernest Jones, a dentist who helped establish the UW School of Dentistry in 1946. She assisted in this endeavor and served as Jones’ secretary during his tenure as the first dean. Dorothy later was appointed the school’s administra-

tive secretary with faculty status. She worked under two additional deans until her retirement in 1974.

Bill and Dorothy Kipple

If you would like to learn more about supporting ME students and the work of the department, please contact April Johnson by phone at 206-543-8779 or by e-mail at ajohnson@uw.edu.

Chair’s Corner

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to move forward and to meet the challenges of a rapidly changing technology base.

Recent successes include establishing large research centers in intelligent materials and systems, advanced composite materials, marine renewable energy, human photonics, and quantum system engineering. The department is now the College of Engineering’s leading force for intellectual property creation based on issued patents and filed disclosures.

I welcome your ideas and input. Please feel free to contact me or drop by my office when you are visiting the UW campus.

Charles J. “Kip” Kippenhan

Professor Emeritus Charles J. Kippen-

han, passed away on September 23. He was an ME faculty member from 1963 to 1988. He was recruited from Washington Univer-

sity in St. Louis, and hired as professor and chair of mechanical engineering. Kippenhan’s research specialization was in heat transfer and thermodynamics, and he frequently collaborated with faculty in architecture in these areas. “Kip” was an early practitioner of numerical analysis. He was respected for an amazing breadth of knowledge, even in areas such as art, which lay outside his professional expertise. After stepping down as chair in 1973, Kippenhan continued to teach for another 15 years, retiring in 1988.

After retirement, he continued to keep informed on department matters and for many years he regularly attended the annual Faculty Advance in September. Wine making was also one of his interests in retirement. During his teaching years he began making wine with colleagues Ashley Emery and John Bodoia. His interest led him to purchase a vineyard, which he ran with his son.

The end of this story is not yet written. “We are still working on building EnVitrum as a company and refining our products for commercialization,” said Marchelli. In June, EnVitrum was named a semi-finalist in the Pacific Northwest Cleantech Open. Renuka and Grant are refining their business plan in preparation for the next round of judging, with hopes of making it to the national competition. What started with imagination, a pile of junk, and a whole lot of experimentation and hard work could soon become a green product used in building construction.

EnVitrum

Continued from page 1

Plants growing in an EnVitrum wall.

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Building a Molecular Observatory

Direct observation of molecular structure is a long-standing dream. In 1959, physicist Richard Feynman said: “It is very easy to answer many of these fundamental biological questions; you just need to look at the thing… I put this out as a challenge: Is there no way to make the electron microscope more powerful?”

The answer to Feynman’s question, it turns out, is no. But there are other possible ways to accomplish the goal. “I believe the realization of Feynman’s dream may be close at hand,” said Professor Joseph Garbini. He is a member of the UW Quantum Systems Engineering (QSE) group, a collaboration between the departments of Mechanical Engineering and Orthopaedics. QSE’s goal is quantum microscopy: the direct observation of single biomolecules; in situ, in their native conformation; with 3D Angstrom-scale resolution; and by a non-destructive process.

The QSE group is pursuing magnetic resonance force microscopy (MRFM), a combination of three technologies: magnetic resonance imaging, Angstrom-scale probe microscopy, and continuous quantum observation. The aim is to provide medical researchers observational access to every object in molecular biospace.

MRFM is based on the detection of magnetic spin resonance. In the familiar MRI medical scanner, nuclear spins are modulated to produce small variations in the local magnetic field. An electrical oscillator is coupled to the magnetic field to detect the distribution of nuclei and produce an image. One approach to molecular-scale imaging might have been to build an MRI scanner sufficiently small to image a molecule. Unfortunately, as an MRI is scaled down, the electrical oscillator becomes impractically small to detect the tiny magnetic field.

MRFM was invented when another member of the QSE group, Professor John Sidles, suggested using a mechanical rather than electrical oscillator to detect the magnetic field. The mechanical oscillator consists of a cantilevered beam with a magnet at the tip. As the mechanical oscillator is scaled down, its sensitivity to the small magnetic forces increases, and the damping decreases.

An MRFM experiment is pictured above. The cantilever has a diameter of one square micron, while the sample size is about 100 microns.

The coil at right supplies the radio frequency magnetic field used to modulate the spins. The modulated spins exert forces through the magnetic tip on the cantilever. The fiber optic interferometer above the cantilever measures the motion. An image is produced by scanning the sample in three dimensions relative to the cantilever, and observing the resulting cantilever motion. In this configuration, the cantilever is 100 micrometers long. The experiments are performed in vacuum to minimize damping, and at cryogenic temperatures (10 mK–10K) to reduce Brownian motion.

You might ask, “I’ve seen images of individual atoms made with atomic force microscopes (AFM). How is MRFM different?” AFM can detect atoms only on the surface of a sample. Because the magnetic resonance occurs at a fixed distance from the magnetic tip, MRFM is able to “see” into the sample to resolve the structure below the surface. Forces exerted on the cantilever in MRFM are one million times smaller than those in an AFM. Achieving this force sensitivity is among the many challenges of designing a practical MRFM imager. “About 15 research groups around the world are working on MRFM, and progress has been steady,” said Garbini.

At the UW, QSE is concentrating its efforts on a specific MRFM sensing enhancement: dynamic nuclear polarization (DNP). The attractiveness of DNP is based on the recent realization that single-proton resolution (~0.1 nm) may not be necessary to resolve atomic structure. Advances in simulation are making it possible for an image with resolution of approximately 5 nm to be “pulled in” to its final form by means of molecular modeling.

The challenge of DNP research is that the fundamental physical framework needed to design the imaging instruments and to plan experiments is not available through semi-classical analysis previously used. Quantum simulations of large numbers of interacting spins are necessary to predict, for example, the spin diffusion tensor in a large magnetic field gradient. Professor Garbini believes that the UW QSE group is uniquely positioned to provide that theory, to perform the required experiments, and to coordinate that work with other MRFM researchers.

See http://courses.washington.edu/goodall/MRFM/