SANTA CLARA UNIVERSITY
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A Century of Engineering Excellence
SPRING 12
School of Engineering
engineering news

DEAN'S MESSAGE

Spring is here, and with it comes the close of our Centennial celebration for the School of Engineering. To mark the occasion, we recently honored 12 luminaries from the past 100 years of Santa Clara Engineering with the Centennial Award. These illustrious individuals have had a tremendous impact on furthering not only the engineering profession, but the School of Engineering at Santa Clara University as well. They are leaders in community service, professional accomplishment, entrepreneurship, scholarship, philanthropy, social justice, and promotion of excellence in Jesuit teaching, and we are enriched immeasurably by having had them in our midst:

William J. Adams '37
William N. Carrico '72
William S. Carter '71, '95
Michael L. Hackworth '63
Jack D. Kuehler '54, '86
Jeffrey A. Miller '73, '76
John L. Ocampo '79
Eugene A. Ravizza '50
Dragoslav D. Siljak
George L. Sullivan
William E. Terry '55
Maynard G. Webb

Spring also brought another reason for celebration here at the School of Engineering as 65 teams of graduating seniors presented their capstone projects to an audience of parents, alumni, industry collaborators, University administrators, and friends at our 42nd Annual Senior Design Conference held on May 10. This edition of *Engineering News* features stories about a number of their projects. I hope you enjoy reading about the excellent work being done by our undergraduates. Who knows? There just may be a future Bicentennial Award recipient found among these pages!

Godfrey Mungal
Dean
School of Engineering

Photo: Heidi Williams

From left: Jessica Song, Stephanie Mow, and Alison Nojima in the Civil Engineering Laboratory.

TREATING THE TREATMENT PLANT

Optimizing energy recovery for the Sunnyvale, California, Water Pollution Control Plant is the task civil engineering students Stephanie Mow, Alison Nojima, and Jessica Song took on for their Senior Design project.

While anaerobic digesters at the plant were already producing methane gas to offset the facility's energy consumption, the team researched ways to increase output through digestion of fats, oils, and greases (FOG) obtained from local restaurants. "We're considering a system where grease haulers would deliver FOG to a new receiving station at the plant in the early morning hours instead of taking their load to the landfills or other disposal locations," said Nojima. "The material will slowly be fed to the digesters during the day, creating methane gas, which is captured and converted to energy. Any excess energy can be sold as credits."

While all three students are civil engineers, their interests within the field vary. Mow focused on sustainability and marketability, researching the economics and environmental benefits to calculate costs, determine savings in landfill emissions, and estimate anticipated kilowatt hours of energy production. Song, with her focus on structural engineering, investigated options for changing the fixed cover on the digesters to a flexible membrane to better manage the variability in gas pressure. For her part, Nojima, as an environmental engineer, designed the receiving station and mixing system and evaluated the additional capacity that could be treated by the digesters.

"I wanted to do something sustainable for my senior project," said Mow, "and this project just helps the environment in so many ways while also having an economic benefit for the plant. Besides selling energy credits, they can also receive a tipping fee of about five cents per gallon for accepting the waste." Nojima agreed, "It's rewarding to take something that is considered waste and turn it into something so valuable."

BRINGING 3D GAMING INTO FOCUS

Photo: Courtesy of Eric Rahman

Ryan Shin and Eric Rahman at work on their Senior Design project.

In the virtual world, eye strain, motion sickness, and blurred vision can make the 3D stereoscopic experience a real headache for gamers—one that computer engineering seniors Eric Rahman and Ryan Shin (electrical engineering double major) are alleviating with their computer middleware.

"The current problem with 3D," said Rahman, "is that the rendering makes it difficult for the user to focus on individual elements. To solve this problem, the program needs to know in advance what the user will be looking at. The game tells our middleware what's in the scene, and we deduce what the player is looking at. It's basically like a Google search within the scene: the user is probably looking at one of the more 'popular' results in the scene."

Using a commercial grade EEG device, keyboard, and mouse, the pair finds patterns formed by brainwaves during play that can be programmatically identified. Next they look at user input to see what the user is actually doing as these patterns are being formed. "Merging the two is important because brain patterns alone can render false positives, as can user input by itself. By combining the analyses we are a lot more certain of what the user is trying to do—we call that a Brainwave Fingerprint," Rahman explained.

Since beginning work on their capstone project last summer, the undergraduates have reached out for help from friends and mentors at Silicon Valley neighbors Cryptic Studios and NVIDIA. They hope to return the favor with a product that will open the market to more users which, in turn, could drive down the cost for 3D gaming systems.

After graduation, Shin will start work at Amazon.com in their Web services cloud computing division. Rahman said he wants to take on the "deepest, most exciting problems in game programming." He added, "At Santa Clara, we talk about the three Cs of Jesuit education—competence, conscience, and compassion—but I would like to see a fourth C added—courage. I want to jump into my career taking risks, tackling problems outside my comfort zone. That's the engineering spirit."

DESIGNING FOR SOLDIER SAFETY

SCU engineering students use a variety of techniques for finding their senior projects. Some choose to work on a problem that has been bugging them and some choose from a list of suggestions offered by their faculty advisor, but Jerrick Hayes, an electrical engineering transfer student, used a different approach. "I was looking for a project that was original and of a complexity that an undergraduate could take on with the help of advisors." So he went trolling websites last summer and found an open solicitation on a government site to develop a body wearable radio direction finding antenna that would give soldiers the information they need to navigate while reducing the likelihood of detection.

Described in the solicitation as a "DF Mantenna," the device would likely be a lightweight, one-size-fits-all vest that eliminates the need for raising an antenna while in a combat environment. The information received by the vest's antenna array would be transmitted to a handheld device to allow covert direction finding.

Having recently studied antenna arrays with assistant professor Talal Al-Attar, Hayes immediately thought of an adaptation for a microchip patch to maximize the antenna's inherent abilities. What really sealed the deal was seeing electrical engineering professor Tokunbo Ogunfunmi's work listed as one of the reference materials on the solicitation. "Having taken classes with Dr. Ogunfunmi, I knew that with his help in the area of digital signal processing and with Dr. Al-Attar's expertise in RF, this was a good project for someone like me to take on." Dr. Al-Attar also enlisted the assistance of electrical engineering doctoral student Ben Horwath.

"We're adapting patch antennas and modeling arrays that we hope to be capable of giving us the bandwidth we're looking for while providing the directivity that we need. It is a challenge to get the microchip patch to resonate within the required 50–500 MHz bandwidth without taking up too much space, as identical arrays need to be positioned on both the front and back of the vest to provide an accurate direction," Hayes said.

Once the technology is designed, Hayes will write the proposal. "Working on a real problem for my Senior Design project was most attractive to me, and collaborating with Ben, Dr. Al-Attar, and Dr. Ogunfunmi has been a great experience; their leadership has maintained the focus of the design process. This is a good project; hopefully we can really make something out of it."

FINDING STRENGTH IN NATURE

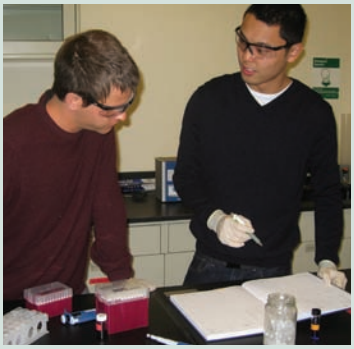

Photo: Heidi Williams

Jens Olesen and Matt Blanco are recording promising results for their nanobioglue.

Nature is always the best engineer and now bioengineering students Matt Blanco and Jens Olesen are hoping that, by mimicking properties found in marine life, they can improve the adhesive strength of medical glues.

"Biological organisms in nature, such as mussels and barnacles, are known to release secretions containing nanoparticles when adhering to surfaces," said Olesen, an exchange student from Sweden studying at SCU this year. "Using this concept," he continued, "we hope to improve the adhesive strength of cyanoacrylate glues by adding carbon nanotubes. If our assumption is correct, our findings would guide the development of stronger medical glues."

To prove their theory, the team would need a supply of glue, so they contacted Chemence Medical, a leading manufacturer of medical wound closure adhesives. "They offered to share as much of their Derma+flex® adhesive as we needed as long as we promised to share our results with them," said Blanco. "Of course, we are happy to do that."

With the glue in hand, testing can begin. First, the team disperses varying amounts of carbon nanotube powder into glue, either directly or using a solvent vehicle such as acetone. Next, the altered glue—*nanobioglue*—is used to affix two titanium plates, and the plates are loaded into an Instron machine to measure the amount of force needed to break the adhesive bond.

"At first we tried using Teflon plates to simulate a bone-like structure, but it was too slippery for the glue. Since titanium implants are

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A FORMULA FOR SUCCESS

Photo: Courtesy of Keenan O'Flaherty

In front row, Mike Oberti (far left) and Keenan O'Flaherty (far right) with Formula Hybrid team members.

Five teams, five faculty advisors, twenty undergraduate students, thousands of decisions, and a million details are all focused on one big contest: SAE's Formula Hybrid. The competition challenges engineering college and university students to design, build, and compete with an open-wheel, single-seat, electric or plug-in hybrid-electric racecar conforming to a formula that emphasizes drive train innovation and fuel efficiency in a high-performance application.

Five interdisciplinary teams—electrical, body, powertrain, suspension, and controls—have been working on this challenge for more than a year, not only in preparation for the fierce competition, but also because this is their Senior Design project. Managing the efforts and pulling all the details together are two 29-year-old transfer students, Keenan O'Flaherty and Mike Oberti. "We set ourselves up like a start-up engineering firm," said O'Flaherty. "Aside from our work on our own teams, Mike operates like the systems engineer and chief operating officer, overseeing all design and build stuff to ensure that everything fits together from all the groups; I operate like the CEO, handling the administrative end of the big picture."

"Santa Clara had never participated in this competition," said Oberti, "so it was extremely difficult to get things started. Just recruiting people to join the teams was incredibly challenging. We hand-selected those people who were excited to work and could contribute a specific expertise or quality to their team, but it was risky for people to sign on as we were initially having trouble lining up faculty advisors. We submitted a white paper listing all the reasons these types of projects fail—lack of funding, not a big enough team, not enough advising—found all the weak points and addressed them, and eventually received conditional approval to pursue the project in March, 2011. At any time, safety issues could have shut us down. SCU had never had to deal with students working with more than 50 volts of electricity—ours is a 130-volt system. So our electrical team had to make a presentation to the University's Environmental Health & Safety director and an outside fire consultant on why the project was safe and why we could go forward." O'Flaherty added, "I can't tell you how many times we heard the word 'no,' but we were persistent and just kept going."

With initial approval granted, the teams set about designing and building a diesel hybrid vehicle for the competition. Their car, which they built from the ground up, boasts a continuously variable transmission to perform at peak efficiency, combined with a diesel and hybrid electric engine. Biodiesel, an organic and purely renewable source, will be used to fuel the vehicle. Other sustainable elements: their design calls for minimal material; they chose to use Teflon aluminum titanium because it will not degrade the environment; and no heavy metals are used.

"Transportation accounts for twenty-seven percent of the world's energy use," said O'Flaherty. "With the University's focus on sustainability, the Formula Hybrid competition just seemed like a natural for Santa Clara, and Mike and I really wanted to start a legacy in transportation sustainability here at SCU. There have been a lot of hurdles to overcome, but it has been worth it." Oberti agreed, "The experience is overwhelming in a sense. Every issue we ran into is ingrained in me now; you can't pay for experience like that. It's been good and it's been bad, but everything is usable. Now we have six juniors lined up to take up the work next year. To leave our footprint here, to bring this project to SCU has been really great."

SCU ROBOTICS PROGRAM LAUDED BY NATIONAL ACADEMY OF ENGINEERING

Santa Clara's Field Robotics Program was recently recognized as a model by the National Academy of Engineering (NAE) for successfully infusing real-world experiences into the undergraduate program and will be included in a printed guide produced by the NAE to serve as an example of best practices for other educational institutions.

Robotics Laboratory Director and Associate Professor of Mechanical Engineering Christopher Kitts runs the interdisciplinary field robotics program in which teams of students design, fabricate, test, and demonstrate high-quality robotic systems to operate on land, sea, air, and space.

"Our program was established out of the desire to provide interdisciplinary, hands-on engineering education that engaged and challenged students in exciting ways, and it has been very successful in meeting that goal," said Kitts. Systems range from underwater robots to satellites, and once operational, are deployed and operated by students to meet the specific needs of a wide range of external clients and collaborators from government, academia, industry, and nonprofit sectors.

Over the past 10 years, interdisciplinary projects have included involvement by faculty and students in a wide variety of academic departments, including mechanical, electrical, computer, civil, and bioengineering, math/computer science, physics, archeology, and business. "Our projects provide experience in planning, organizing, and managing a team, a development process, and operational activities in a fiscally and logistically sustainable manner," said Kitts, "This creative, holistic approach inspires and motivates students, and the projects afford an opportunity for honing their problem-solving and communication skills, while presenting them with engineering challenges of a caliber appropriate for graduate research."

A typical project involves junior-level design and senior-level capstone activities, and often drives graduate student involvement through thesis research. When the system is completed and ready to be deployed, freshman and sophomore students often join the teams, learning how to safely and efficiently operate advanced engineering systems in the field.

"Santa Clara engineering is committed to providing innovative, hands-on, project-based educational programs," said Kitts; "to be recognized by the NAE for this work is quite an honor."

Photo: Courtesy of Robotics Systems Lab

Using an automated student-built boat and multiple underwater robots, Jasmine Cashbaugh, Thomas Adamek, Sreekanth Madhav, and Ketan Rasal survey fault lines and geological features to create a high resolution bathymetric map of Lake Tahoe's Emerald Bay.

A BLAST FROM THE PAST

Check out our Centennial website for lots of great stories, photos, and memorabilia from our first 100 years!

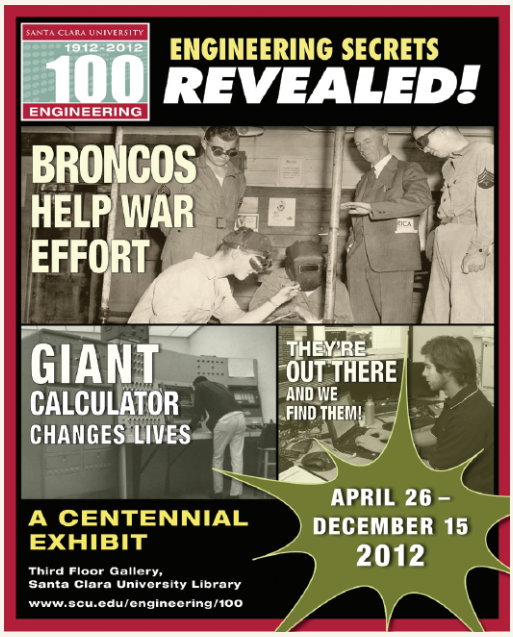
www.scu.edu/engineering/100

Photo: Santa Clara University Archives

VISIT OUR CENTENNIAL EXHIBIT

Were SCU engineering students really graded on their table manners at one time? What does Sputnik have to do with Santa Clara Engineering? Where on earth are Bronco engineers taking a Lab-on-a-Chip, and what is that, anyway? Find the answers to these and many more burning questions with a visit to our archives exhibit; open daily now through December 15, 2012.

www.scu.edu/engineering/archives



EDUCATING FOR ENTREPRENEURSHIP

Photo: Charles Barry

Angel investors Marc van den Berg '83, Christine Hertzog, and Spencer Johnson rate student pitches.

"If you're not in Silicon Valley for entrepreneurship, you're paying too much for rent," said John Giddings '91, SCU Engineering Management and Leadership adjunct professor, co-founder of The Silicon Valley Angels (now Tech Angel Group), and vice president of business development at TeleLumen. He was addressing a group of undergraduate and graduate students gathered for the first in a series of School of Engineering *Lunch with an Entrepreneur* programs.

"The engineering mind lends itself to the flexibility that is required for entrepreneurship," he said, as he gave concrete guidance on how to turn ideas into reality while also holding down a job. "Take your ideas out and talk about them with your buddies; start a conversation; take the next step; that's how entrepreneurship begins. We have an incredible community in Silicon Valley. Tap into other people, get to know 'yes' or 'no' quickly—don't sit on an idea for two years. If it's not advancing within three to four months, move on with what you have learned."

Aside from lending his expertise over lunch, Giddings also teaches a graduate course, Technology Entrepreneurship (EMGT 373). Ahmad Alghazi, an entrepreneurial graduate student who took the class last year, said "We basically learned all the factors we needed to get an idea launched, and it's working for sure."

"In the class, we talk about the entrepreneurial career path," said Giddings, "how to recognize the other spices people can bring to the recipe, legal issues, business plan writing, financial planning, operations, the pitch, myths and realities, challenges and rewards." At the end of the quarter Giddings brings in venture capitalists such as Marc van den Berg '83, from Technology Partners, investors in cleantech and life sciences, to hear the students' five-minute pitches and offer recommendations to the eager innovators.

Giddings, who was an Eagle Scout, advises the future entrepreneurs, "Be prepared to do what's never been done before. It's up to you to cause lightning to strike instead of just waiting for it. This class is about going out and embracing adventures; share—take your skills out into the world. It's the Santa Clara way."

FINDING STRENGTH...

(Continued from Page 2)

so common today, we decided to use that material for our test," said Blanco; "now we are running tests to see if it takes more force to break the plates apart than it does without the nanoparticles added to the glue."

Blanco, who plans to go on to medical school after graduation, was originally enrolled in a different engineering program, but switched majors when he discovered bioengineering during orientation. "The bioengineering program takes biology, chemistry, physics, and engineering and combines all these different fields together. I've really enjoyed it," he said.

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