A NEW ANGLE ON ENVIRONMENTAL RESEARCH

For some time now, students in the Robotics Systems Laboratory have been working on controlling a set of automated devices to work together in a cluster. This year, an interdisciplinary senior design team is taking the technology to the next step by creating ANGLER (Autonomous Network for Gradient Location and Environmental Research), a group of robotic kayaks that sense and navigate by physical gradients while transmitting data about the conditions in the water.

"Our challenge has been to develop a prototype that includes an integrated sensor package for measuring water temperature, oxygen content, and salinity to see what the environment has to offer," said mechanical engineering senior Jake Pfitsch. "This way, we can learn how the runoff from nearby algal farms may be affecting the fishing industry and surrounding environment."

With three kayaks working in concert, the team can map a wide area of anoxic concentration at one particular moment according to gradients and data tracked by their controls system. "This ability to map a large area and get a snapshot in time is important because with tides and intermittent phenomena, algae can grow relatively quickly," said Dean Willmert, also a mechanical engineering major.

Two electrical engineering students, Greg Emmanuel and Alvaro Astray, one more mechanical engineer, Xander Wroblewski, and engineering physics major Mike Vlahos are also teammates on the project. "It's really an interdisciplinary endeavor to design and implement the mechanical, electrical, and controls systems," said Pfitsch, "and we're also collaborating with two other universities, Milwaukee School of Engineering and St. Louis University. We have a conference call with them once a week, so we have to communicate clearly and stay on the same page while sticking with our design constraints. With so many different perspectives, it makes the project really interesting."

Early on, the SCU team sought the advice of experts at MBARI (Monterey Bay Aquarium Research Institute). "They pointed out that our sensors were placed too close to the motor, which would cause turbulence and electronic interference," said Willmert. "It was great to be able to pick the experts' brains to help save us some trouble."

Photo: Gregory Emmanuel

Xander Wroblewski deploys one of the robotic kayaks.

Still, as Willmert noted, the students enjoy the challenge of trial and error: "When you have access to engineers who know a lot more than you, finding the balance between doing things on your own as opposed to asking someone who knows how to do it is an experience of its own."

"We've learned new ways of thinking about engineering problems by working on this project all year, for sure," added Pfitsch. "There are so many factors, you just kind of have to know from your previous experience how to proceed and figure things out."

GIVING TRAFFIC THE GREEN LIGHT

Nick Bergseng and Riccardo Franchi, senior computer science and engineering students, don't just view waiting at stoplights as a frustrating inconvenience, the way most of us do. Instead, when they see cars inch from one red light to the next, they recognize the millions of hours of productivity being lost and the tons of CO_2 needlessly emitted into the atmosphere. So they focused their attention on this problem for their senior design project.

"Obviously, if you hit one green light while driving the speed limit, you should hit the next and the next," they said. "Although most stoplights have their own traffic controller that takes in information from a corresponding inductive metal plate installed in the road, the controllers don't communicate from one light to the next along the street. This seemed like a simple fix to us," they continued. "It's the talking back and forth that is missing."

"Large cities around the country are addressing this problem with elaborate, high-tech traffic control systems that are impressive, but are outside the scope of what is essential to keeping traffic moving and minimizing wait time," said Bergseng. And with a $20 million price tag, they are out of reach for smaller, budget-constrained cities like Santa Clara. It would be like having a flat tire on your bicycle and buying a Ferrari instead of just patching the tire up." Franchi added, "We knew we could 'McGuyver up' a low-cost system that would work."

Their proof of concept solution uses Quadstone Paramics software and an inexpensive, commercially available microcontroller to connect existing signal controllers via the Internet. It may not be high tech, but it is appropriate technology for the task—an important consideration for local governments managing limited funds. "Ta-dah!" they said. "New light timings at a cost that is four orders of magnitude cheaper. At a minimum cost, we've come up with a system that is appropriately scaled, modular, ready to implement, and easily upgraded."

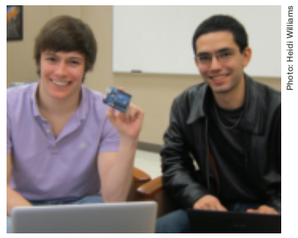

Photo: Heidi Williams

Nick Bergseng (left) and Ricky Franchi.

Bergseng and Franchi say that working on this year-long project has been a great experience. "This is what we're going to be spending the next 30 years or so doing—taking a problem, finding a solution, presenting a design, and implementing it," said Franchi. Bergseng agreed, "I love the senior design project. People say you learn more in a week on the job than you do in all your classes; this gives you the opportunity of having that 'week on the job' type of experience you don't get in class or lab."

MIX
Paper
FSC FSC® C004651

Santa Clara University
School of Engineering

The Jesuit University in Silicon Valley

Santa Clara University
500 El Camino Real
Santa Clara, CA 95053

SCU OMC-8072E 5/2011 1,500

SANTA CLARA UNIVERSITY
SPRING 11
School of Engineering
engineering news

DEAN'S MESSAGE

Recently, Santa Clara University adopted a strategic plan to guide our curricula, programs, and decision making over the next several years. The five areas of focus—excellence in Jesuit education, engagement with Silicon Valley, global understanding and engagement, justice and sustainability, and academic community—are places where the School of Engineering has already been focusing attention for some time as evidenced in our students' senior design projects.

For the past year, engineering seniors have worked diligently on the capstone projects they recently presented before an audience of alumni, industry collaborators, faculty advisors, family, and friends. The selection of their projects says a lot about the excellence of their Jesuit education as they put their expertise to use tackling some of the most challenging problems of our age. Many took advantage of SCU's location in the heart of Silicon Valley, calling on local industry leaders to serve as advisors. A number chose to focus on sustainability research for projects at home or around the world with teams that include not only engineering students and advisors but teammates from our business school and academic advisors from external departments across campus. Still others have partnered with various universities around the country and non-government organizations.

The School of Engineering is dedicated not only to furthering the knowledge, compassion, and integrity of our students, but also the goals of the University. In this edition of *Engineering News* you will see how well we're doing with both. Enjoy!

Godfrey Mungal
Dean
School of Engineering

Read more: **www.scu.edu/strategicplan**

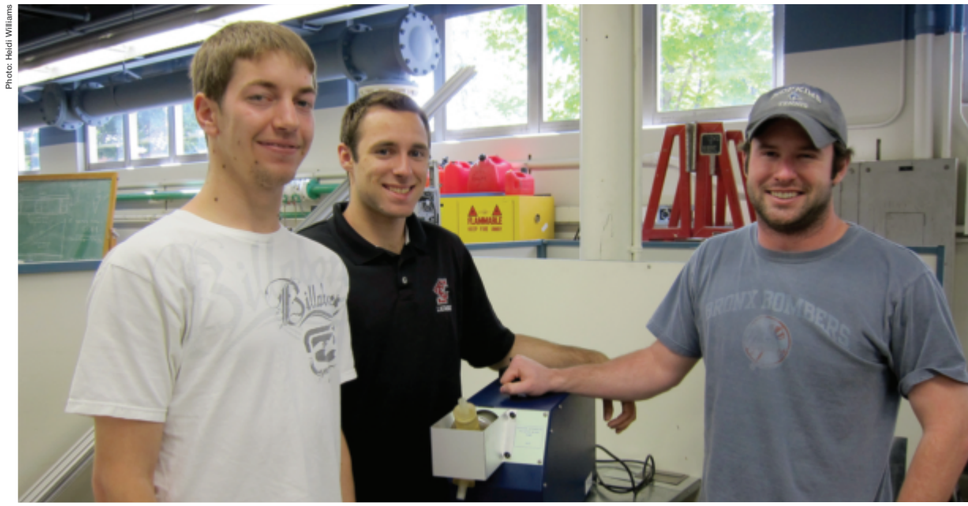

Photo: Heidi Williams

From left: Billy Hendricks, Nick Devich, E.J. Hayes.

GETTING TO THE HEART OF ENGINEERING

Nick Devich, a mechanical engineering senior, found his senior design project while working as an intern at Sadra Medical in Los Gatos, California. The innovative company needed a test fixture for their prosthetic aortic valve, so Devich enlisted classmate Billy Hendricks' help, but needed one more teammate to get the job done. After pitching the project to fellow seniors during their weekly design class, Edward (EJ) Hayes was on board. His experience interning at Velomedix, a small start-up in Menlo Park, made him an asset for the team.

With so much riding on the efficiency of the device, it is critical that the prosthetic valves function perfectly, so the team designed and built an inline manufacturing system, which subjects the devices to a fluid flow that imitates the heart's pulsatile flow in order to verify that the valves are free of all known manufacturing defects. They included everything from ultrasonic flow rate monitors and transvalvular pressure and temperature sensors, to a high-speed camera for visual inspection and quality assurance. The result? A fixture that performs tests within an environment equal to that of the human body to effectively measure the safety of the device in less than a quarter of the time of the previous test system. "We've also improved the ease of use for operators on the line," said Hendricks.

"Most companies don't put this type of project in students' hands," said Devich, "but they came to us and said 'we need a test fixture,' and left it up to us to design, test, and construct the system for them." This entailed months of meetings with Sadra personnel—everyone from junior and senior engineers to vice presidents and the CEO—to define the specific (and seemingly ever-changing) needs for the system.

"Getting all the requirements satisfied was stressful," said Hayes, "but the scariest moment was when we learned Sadra was being acquired by Boston Scientific, right when we were getting ready to purchase a $16,000 pump." Fortunately, the new owners were equally enthusiastic about their student partners, so funding for the $50,000 project was not in jeopardy. "It was a massive relief," said Hayes.

The teammates agree the experience has given them an incomparable opportunity to work with industry on a project with real value. "Mechanical engineers have so much to offer the medical device industry," noted Hayes., "You don't have to be a bioengineer to contribute; MEs have very applicable knowledge for this field."

SoE RECEIVES $1.142M KEEN GRANT

Photo: Mike Rasay

Students test their Innovation Challenge design.

The practice of promoting an entrepreneurial mindset among undergraduate engineering students received a big boost from KEEN, the Kern Entrepreneurship Education Network, with a $1,142,000 grant to SCU's School of Engineering.

The grant is a mark of the organization's high regard for Bronco engineering as a model for other universities based on our expertise in interdisciplinary, hands-on engineering and industry collaboration that produces real products and services with real customers. SCU faculty members Christopher Kitts, director of the Robotics Systems Laboratory, and Ruth Davis, associate dean for undergraduate studies, head SCU's KEEN program and lead KEEN schools in the area. Approximately 20 universities are funded nationwide.

With this grant and funding from a previous $50,000 award, SCU has added new courses that contribute to a culture of innovation and entrepreneurial thinking and has initiated innovation competitions, bringing engineering and business students together to work on challenges for BMW, NASA/Ames, and NVIDIA.

"This funding provides an exceptional opportunity for our engineering students to gain experience harnessing technical innovation for direct customer benefit and becoming actively involved in project management, systems engineering, financial planning, costing, etc., while working with and learning from their peers in the business school," said Kitts. "A number of our senior design teams include one or more business majors who have been working alongside the engineers all year on their capstone projects."

Co-ops, speaker series, mentoring, and club activities are also features of SCU's program as is close collaboration with partners from other KEEN universities such as Milwaukee School of Engineering, St. Louis University, and Baylor University. One objective of the university collaborations is to establish the KEEN organization as a leading academic network in providing world-class education in entrepreneurial engineering education.

"This grant allows us to provide many new, exciting educational opportunities," said Kitts, "some of which are best of class practices already being used by other universities in the KEEN network. At the same time, the foundation is particularly impressed by the manner in which we run some of our long-term 'entrepreneurial enterprise' projects, to the point that they have funded us to export this capability to other universities."

Read more: **http://innovate.engr.scu.edu** and **www.keennetwork.com**

*LED*ING THE WAY TO OPTICAL WIRELESS COMMUNICATION

You could say Will Cook and Dylan Rust, electrical engineering seniors, have seen the light. But when these two see light, they envision a method for transmitting data using light-emitting diodes (LEDs) and photodetectors within the visible and infrared frequencies of the electromagnetic spectrum. For their year-long capstone project, the pair is designing and testing an indoor wireless data distribution system that doubles as an energy-efficient lighting system with little to no ultraviolet radiation.

"The idea is that since radio waves are already in use within a certain bandwidth associated with data transmission, we can also have visible light operating in the same region without interference," Rust explained. "Optical detectors work in the same way our eyes function by reading a light signal rather than a radiofrequency signal—just as our eyes recognize light, but our vision is not affected by radiofrequency waves."

Including this additional layer of connectivity is "like adding more lanes to the freeway to ease traffic—it may allow more information to flow at a speed that is potentially much faster," Cook points out.

Much of their research is focused on determining where this type of system could be put to best use. "We're gathering data on what size array would be needed to diffuse illumination in a room like an office without windows, the characteristics of the 'noise' produced by daylight in a room with windows or a semi-outdoor space, how much power is needed to provide enough light for the signal to overcome interference, and on what specific components will maximize the efficiency of the system," they said, adding, "It takes a bit of guesswork and some helpful input from our advisor, Dr. Sarah Kate Wilson, but it's looking good right now!"

Photo: Heidi Williams

Dylan Rust (left) and Will Cook at work in the lab.

FACULTY NEWSMAKERS

Terry Shoup

Ed Maurer

Recently, Terry Shoup, professor of mechanical engineering and former dean of the School of Engineering was inducted into the Silicon Valley Engineering Hall of Fame;

Edwin Maurer, associate professor of civil engineering, received a Fulbright award. Read all about their stellar accomplishments here:

www.scu.edu/engineering/enews/2011spring.

WE'RE TURNING 100!

It's a once-in-a-century event—the School of Engineering at Santa Clara University is turning 100! "We will celebrate our centennial all year long, beginning in October 2011, with our *Biggest Bash Ever!* event during Grand Reunion weekend, and continuing right on through commencement in 2012," said Dean of Engineering Godfrey Mungal.

HEADS, HEARTS AND HANDS AT WORK FOR HAITI

Three civil engineering senior design teams are helping Haiti rebuild stronger and more affordable homes. Students Jake Echeverria and Chris Sampson have researched and tested new material and building techniques developed in conjunction with EBNet (Ecological Building Network), a group of architects and engineers in the Bay Area who are volunteering their skills to create model homes using sustainable building materials to help in the reconstruction of Haiti. Their method puts bamboo poles filled with mortar made from earthquake rubble into braced frame and truss systems, creating a structure sound enough to withstand future earthquakes and hurricanes. A special rebar dowel protected by a soda-pop bottle top provides ductility needed to resist seismic actions while protecting the bamboo frame connections from overstress. The bamboo-framed seismic-resisting system is intended to stimulate a local bamboo forestry industry while maintaining affordable construction.

Meanwhile, seniors Maura Cyrus, Nicholas deCesare, and Alvaro Lacayo have designed and tested a new concrete block incorporating recycled rubble from the 2010 earthquake to create a product that is designed for its intended use as a weather barrier, partition, and form. The low strength requirements allow a much leaner cement paste to be used, thereby reducing the embodied energy and greenhouse gas emissions associated with Portland cement. The lower cement content and use of recycled materials also makes the block much more affordable than what had customarily been available. Tested successfully earlier this year, the team's blocks will also be put to good use for rebuilding by EBNet in conjunction with their fellow Broncos' bamboo poles.

Photo: Heidi Williams

From left, Lauren Reinnoldt, Danielle Locklar, and Kelli Oura.

Photo: Charles Barry

Chris Sampson (left) and Jake Echeverria confer with Bruce King of EBNet

In building their 500-square-foot house, the third team—Danielle Locklar, Kelli Oura, and Lauren Reinnoldt—collaborated with WellBilt International, Sureboard USA, Necessity Housing, and California Expanded Metal Company. Their home was developed and built from modular structural foam and sheet steel panels, making it lightweight but stronger than anything previously used in Haiti. The structure is designed to withstand regional earthquakes and winds up to 150 miles per hour, and includes a system to collect and filter rain water so residents need not leave home to find clean water.

Knowing that hiring skilled workers to build a home properly generally costs more than Haitians can afford, the students are creating a kit with color-coded, pre-cut, pre-drilled panels so residents can assemble the home themselves using easy-to-follow instructions. The trio demonstrated the ease of their design by assembling an 8-square-foot prototype in just under three hours.

"The goal for the project," said team advisor and Associate Professor Reynaud Serrette, "was to provide housing that is easily assembled, creates in-country industry for fabrication, and stimulates trade between countries in the Caribbean and Mexico that already provide cold-formed steel."

"It's gratifying to see our students' work put to such good use in the world," said civil engineering chair Mark Aschheim. "With their focus on collaborative, ethical, sustainable building for people in need, these students exemplify the type of 'engineering with a mission' we strive for at Santa Clara."

Learn more:
www.ecobuildnetwork.org
www.wellbiltinternational.com
www.necessityhousing.com

BIOENGINEERS BREAK NEW GROUND IN WATER SAFETY DETECTION

It's amazing what a tiny drop of water can tell you when it finds itself in the right hands. For their senior design project, bioengineering seniors Sarah Ghanbari and Nick Giustini are fabricating a portable, fast, accurate, and user-friendly diagnostic device for use in remote areas that will detect the presence of pathogens in a tiny water sample without the need for expensive and bulky lab equipment.

"With more than one billion people in the world without access to potable water, and more than two million deaths each year due to water-borne diseases, this lab-on-a-chip can be an important tool for health management," said Giustini.

"We're basically starting from scratch, trouble-shooting the steps to design and fabricate a microfluidic device that integrates several complex laboratory functions onto a single chip," said Ghanbari. Their new device incorporates a high-throughput concentrator, cell lysis chamber, and electrochemical DNA sensor. First, the concentrator sorts out target pathogens from the untreated water sample at a high-throughput, enabling a large volume of the sample to be processed even in a microscale device. Then, cells are thermally lysed to expose their DNA and, last, the DNA is directed to the sequence-specific electrochemical sensor.

Though they had a basic idea of how their device would look when they started out, the pair acknowledges that the project has evolved greatly over the past year. "It's a big responsibility to make a device that is both rugged enough and easy enough to use in the field, while also figuring out how complex it should be. You have to consider whether each component you want to add is really necessary," said Giustini, who plans to go on to medical school after graduation.

Next year, Ghanbari will continue working with their advisor, Assistant Professor Ashley Kim, and she's already spoken with some junior bioengineering students about continuing work on the project.

"Microfluidics is the new big thing happening in bioengineering now. Many people in third-world countries need help; we're addressing an entire population that's been neglected," she said.

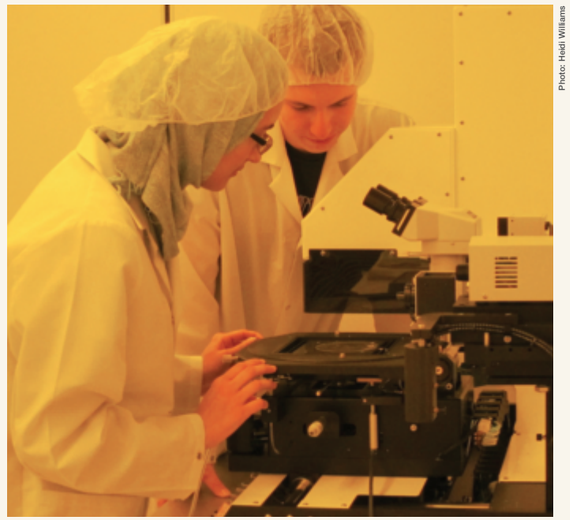

Photo: Heidi Williams

Sarah Ghanbari and Nick Giustini work on their microfluidic device.