engineering news
School of Engineering
SPRING 13
SANTA CLARA UNIVERSITY

DEAN'S MESSAGE

This year, the School of Engineering at Santa Clara University is undergoing an intensive visioning process of determining what we hope to do and aspire to become over the next 10 or 20 years and how we envision our students thriving in the environment we create.

Part of the process entails taking stock of what we believe we are currently doing well in addition to addressing areas in which we want to grow and improve. It is a collaborative process that includes a wide variety of stakeholders—faculty, staff, campus colleagues, students, alumni, and advisory board members—but one thing we all agree on is that our Senior Design requirement serves our students well. In order to graduate, SCU engineering students must complete a year-long capstone research project of their choice and then present it before a group of alumni, industry leaders, faculty, and others. Teamwork is highly encouraged for this hands-on project, and many students choose to work across disciplines or with industry partners or NGOs, giving them an experience that mirrors life in the work world.

In this issue of *Engineering News*, we highlight a few of this year's Senior Design projects. Happy reading!

Godfrey Mungal
Dean
School of Engineering

Photo: Able Hsu '14

From left, David Sippel, Alessi Sia, Alexandra Jabuka-Godwin, and Daniel Tzintzun are getting great testing results from their bamboo gravity system.

ENGINEERING A BETTER CONSTRUCTION METHOD WITH BAMBOO

For the third time, SCU is participating in the U.S Department of Energy's Solar Decathlon, where university teams design, build, and display energy-efficient homes that inspire consumers to build and live more sustainably. And for the third time, Bronco engineers are taking the use of bamboo as a structural material to new, uncharted territory.

Capitalizing on faculty and student research that introduced solid and open web bamboo I-joists in previous competitions (Santa Clara took third place overall with both), a team of civil engineering seniors, working under advisors Mark Aschheim, professor and department chair, and lecturer Tonya Nilsson, designed a bamboo gravity system to replace traditional engineered wood products. And they are getting great results by using bamboo columns in their natural state, compounding the efficiency of the already highly sustainable material by streamlining the process for manufacturing the joists and prefabricated wall segments.

According to the team, the new bamboo gravity system components are particularly exciting because, in addition to functioning structurally as substitutes for conventional timber components, they can be easily substituted physically in established timber construction practice without requiring the trades to master bamboo joinery techniques—thereby eliminating potential resistance to adoption by the building industry.

While a separate Senior Design team works on turning gravity walls into shear walls, this groupis busy documenting their testing results in orderto have their system approved for use in time forthe October competition..

A PRIZED EXPERIENCE

Last fall, when two scientists were awarded the Nobel Prize for their work reprogramming mature human cells to become pluripotent, two Santa Clara bioengineering students were especially excited: they were already helping to commercialize the technology by taking the discovery from theory to reality through their work with ALSTEM, a Silicon Valley biotechnology company.

Under the supervision of ALSTEM founder and CEO Dr. Gary Li and Zhiwen (Jonathan) Zhang, SCU's bioengineering associate professor, students Dane Tomseth and Robert West are working on increasing the reprogramming efficiency and potency of human induced pluripotent stem cells (iPSCs) for their Senior Design project, circumventing ethical issues by using skin cells to mimic human embryonic stem cells. Working across disciplines of biomolecular, stem cell, and tissue engineering, the students have been learning the process of molecular cloning and engineering genetic constructs to generate the iPSCs that may be used to combat cancer, diabetes, Parkinson's disease, and other maladies.

"The benefit for us," said Li, "is that we get to know how students are learning at school and can identify the top candidates for hiring. The students benefit from this collaboration by getting to know how industry works and having the opportunity to work with scientists in the field; they learn to think differently than they do in academia." Li has been very impressed with Tomseth's and West's work: "They are both very smart students and energetic. Once they were assigned the project, they did a lot of research work at home before conducting experiments in the lab. I have had interns from Stanford and Berkeley work with me in the past, and Santa Clara's students are well-trained and every bit as competent."

Santa Clara's strategic location in the heart of Silicon Valley's biotech industry affords a fruitful synergy for Bronco bioengineers. "We've worked extensively to build collaborations with local biotech leaders for internships and co-supervision of Senior Design projects—more than half of which are being done for company partners," said Zhang. "Rigorous academics and collaboration with local industry creates a very strong bioengineering program here at SCU."

Tomseth and West couldn't be happier with their Senior Design experience. "Dr. Li is so helpful," they said. "He's very excited to see us learn. Dr. Zhang provided us with a great opportunity."

Zhang added, "This is exactly what we expected; truly outstanding students can contribute to the advancement of Silicon Valley firms, and our students are doing just that."

"The students benefit from this collaboration by getting to know how industry works and having the opportunity to work with scientists in the field; they learn to think differently than they do in academia."

—Dr. Gary Li, CEO, ALSTEM

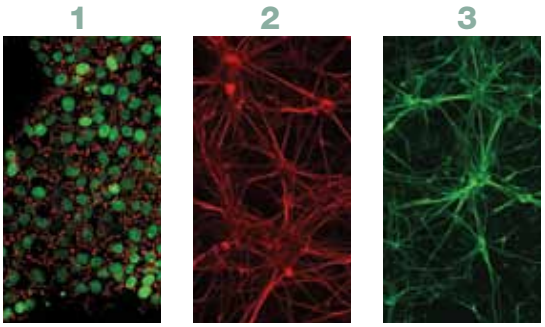


Photo: Gary Li

1: iPSCs stained with nanog and SSEA3 antibodies
2, 3: Neurons derived from human iPSCs

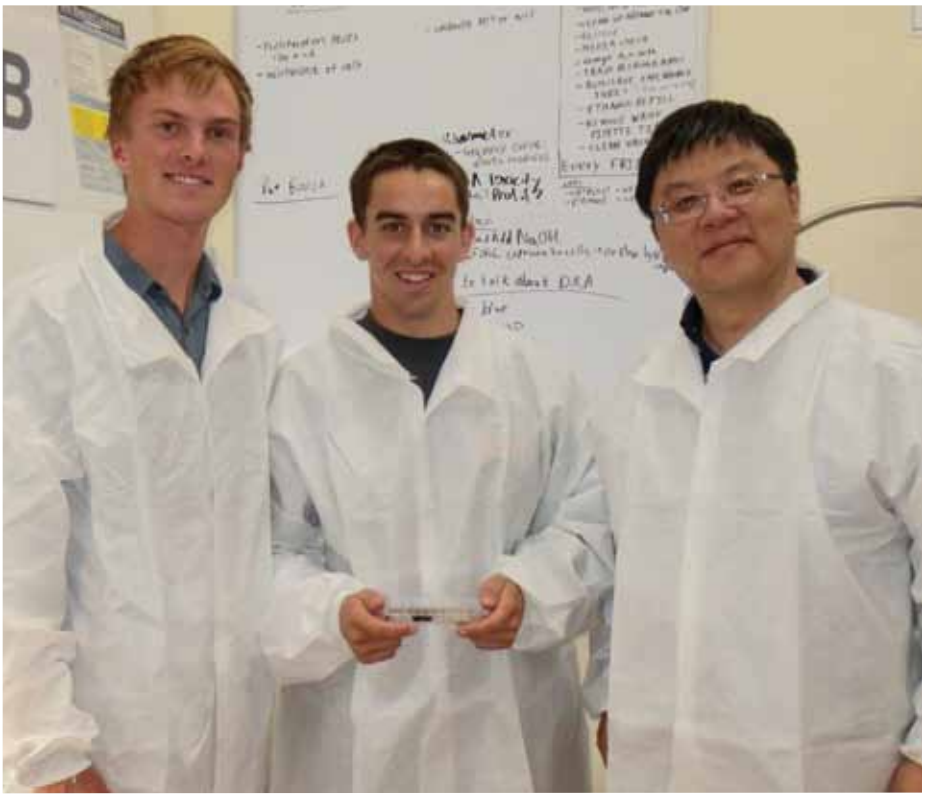
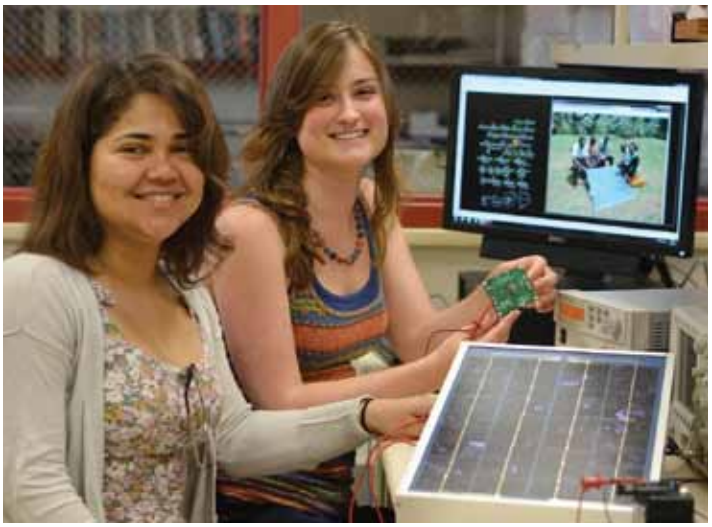


Photo: Christina Shuh '13

From left, Dane Tomseth, Robert West, and Zhiwen (Jonathan) Zhang

ENERGY SOLUTIONS FOR UGANDA

Photo: Able Hsu '14



From left, Jaqueline Barbosa and Kirsten Petersen

With its high insolation levels and lack of an extensive electrical power grid, the African nation of Uganda is an ideal environment for expanding the use of solar photovoltaic (PV) technologies. But poor serviceability of internationally designed and mass-produced solar systems poses a problem for residents as replacement components and solar technicians are scarce. These issues are being addressed by electrical engineering students Kirsten Petersen and Jaqueline Barbosa, who are working together with community-based organization Energy Made in Uganda (EMIU) for a solution to this problem for their Senior Design project, advised by Shoba Krishnan, associate professor of electrical engineering.

At EMIU, housed within the Nsamizi Institute for Social Development in Uganda, local students designed a Solar Home System to provide energy solutions for customers while also offering employment opportunities for local youth who planned to manufacture, sell, and service the product. But for the product to be ready for market, it needed to be both more affordable and more efficient than its initial iteration. Working in SCU's Latimer Energy Lab, using design competencies forged in the School of Engineering's Frugal Innovation Lab, Petersen and Barbosa are collaborating with the Ugandan students to redesign the Solar Home System to improve efficiency, extend capabilities, and increase manufacturability. Among other criteria, the product will be manufactured locally, designed frugally, and will be appropriate for the needs of the end user.

By June, the pair expects to have a finished product that also includes a diagnostic tool for post-sales servicing, spec sheets, quality assurance test plan, and all documentation for each component along with the optimal manufacturing process outlined for their colleagues in Uganda.

"Our hopes for the end result of this collaboration are three-fold," they said, "one, that the people of rural Uganda will have increased opportunities to gain employment and learn marketable skills; two, that they experience improved well-being, safety, and quality of life; and three, that micro-businesses such as cell phone charging ventures may grow from the increased access to power."

HEADING OFF TROUBLE

The concussion that sidelined San Francisco 49ers quarterback Alex Smith last year brought massive attention to the issue of brain trauma stemming from contact sports. With immediate access to the very best sports trainers and doctors, Smith still ran several plays before leaving the game with blurred vision.

Such incidents have led to a focus on standard safety equipment, particularly since studies have made the connection between concussion, dementia, and memory loss. Concerned that there is currently no clear way to detect that a concussion has occurred, computer science and engineering major Kyle Terriere and electrical engineering major Shawno Auwae decided to tackle this issue for their Senior Design project, under the guidance of advisor Sarah Kate Wilson, associate professor of electrical engineering.

"The risk of concussions going undetected is magnified at the youth level where appropriate personnel and equipment are not readily available," said Auwae, "so our team is working to create a device utilizing an accelerometer, microcontroller, wireless communication, and a mobile app, that when inserted in the helmet helps athletes and trainers detect severe head impacts that may result in concussions." Each helmet fitted with the device will send a unique signal to the app which will store the data over a set period of time, aiding diagnosis and treatment. Coaches or parents will have the ability to set an alert threshold for impacts deemed hazardous and create markers to document where the athlete experienced concussion-like symptoms.

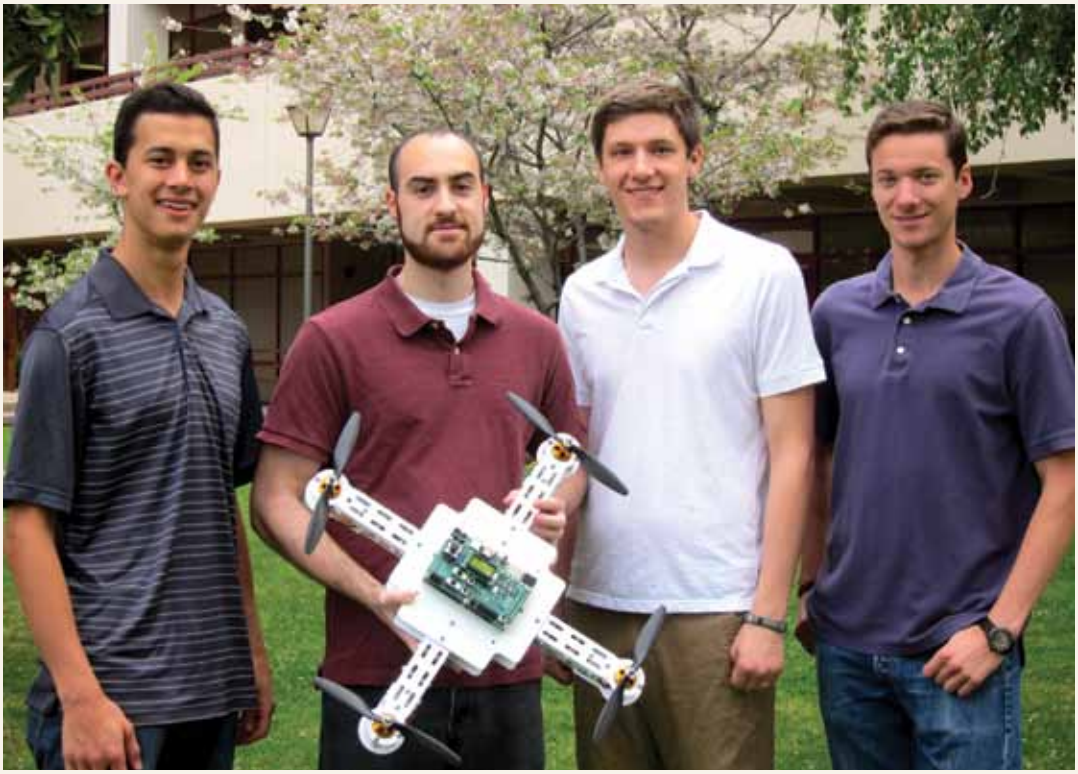
Photo: Able Hsu '14

From left, Kyle Terriere and Shawno Auwae

"Our goal is to end up with a product that could be fit into any helmet, encouraging participation in contact sports like football, without the fear of long-term consequences. We also hope that our device could be modified for use in other areas where brain damage is a concern, such as the military," Terriere said.

MAKING THE SQUAD: SANTA CLARA QUADROTOR AUTONOMOUS DRONE

Photo: Heidi Williams



From left, Mike McCormick, Mark Johnson, Peter Baumgartner, and Jacob Adams

> ***"The challenge in finalizing a design is knowing when to stop."***
>
> ***—Mike McCormick '13***

For Senior Design students, an important step in completing their project is just knowing when it is time to stop designing and start building. Mechanical engineers Jacob Adams, Peter Baumgartner, Mark Johnson, and Mike McCormick reached that conclusion while working on an autonomous uninhabited aerial vehicle (UAV) known as The SQuAD: Santa Clara Quadrotor Autonomous Drone. "The challenge in finalizing a design is knowing when to stop," said McCormick. "As students, we have lots of free time to make tons of iterations, but the point came when we had to move ahead."

While quadrotor UAVs are not new, these Broncos—under the direction of Mohammad Ayoubi, assistant professor of mechanical engineering—are pushing the design specifications to the limit, creating a vehicle that is larger and heavier than previous UAVs. "Our mission is to have a long flight time; we want a camera on board, and the vehicle must be stable in flight, so the quad has to be bigger to hold all the components," said McCormick. "Our structure is expected to be more stable, rigid, and durable than anything commercially available now."

To meet these building requirements, the team determined that Dibond, an aluminum composite, would best suit their needs. "Dibond sandwiches a thermoplastic core between two aluminum sheets. It's strong but light, so it keeps the weight of the vehicle down, which helps flight time and stability," said Baumgartner.

While Baumgartner and McCormick are working on the design and build of the frame, Adams and Johnson are focused on the UAV's control system. "Anyone who searches the Internet can put together a quadrotor that can be flown with a remote control," said Johnson, "but we're taking it to the next level by making the UAV fly itself." To do that, the pair is programming a National Instruments RIO device to communicate with the accelerometer, gyros, rangefinder, barometer, and GPS. Johnson adds, "It's rarely been done to use this flight board to control a UAV, so we're helping to develop something new. It is a powerful tool with field-programmable gate arrays (FPGA) that are programmable to do one particular thing, such as take in sensor data and perform calculations based on inputs to aid stabilization; so it does it very fast. With all the programming happening onboard, it frees the user to spend more time on decisions such as altitude or location."

With their yearlong project complete, Baumgartner and Adams hope to continue their studies in aeronautics after graduation, while McCormick wants to design for a living. Johnson will enter the graduate program at SCU, taking this project in a new and more technically advanced direction. For each, the Senior Design project has given them an opportunity to explore their interests in a manner that Adams likens to an internship experience.

DYNAMIC TRIO CREATES DYNAMIC HEAT MAP

Photo: Heidi Williams

From left, Kurt Jurgens, Jasmine Farias, and Jonathan Ahumada

For computer engineering students Jonathan Ahumada, Jasmine Farias, and Kurt Jurgens, the technical expertise they bring to their Senior Design project is just one aspect that contributes to the success of their work—communication skills and understanding different cultures are also crucial.

The student team is working with HP in Ireland and Fundación Paraguaya (FP) to create a website offering an up-to-the-minute heat map illustrating which areas of Paraguay are most in need of government resources to alleviate poverty based on survey information that is actively being gathered from a growing number of FP field offices. Poverty indicators related to income, employment, health, housing, education, and sanitation may be quickly and easily accessed and analyzed by region using the student-designed app and website that will display a map of Paraguay color-coded red (most in need of government resources), yellow, and green.

Jurgens, a computer engineering major, and Ahumada, a Web design and engineering major and computer engineering minor, were looking for a project that incorporated an element of social benefit, so they turned to the School of Engineering's Frugal Innovation Lab (FIL) for ideas. With its close connection to SCU's Center for Science, Technology, and Society, and access to a vast network of social enterprise alumni from the Global Social Benefit Incubator, FIL connects students and faculty with partners around the world to create solutions for emerging markets. FIL's Mobile Health Lab focuses on computer applications development. Through FIL, the students learned of the work being done in Paraguay. HP had been working with Fundación Paraguaya for some time, but was looking for a more easily readable format for their data, and that is when the SCU students got involved. Jurgens and Ahumada recruited fellow Web design and engineering major, Farias, to their team. The trio immediately got to work creating a Web application that would take the data from HP's servers and display it to users in an easily understandable and efficient manner.

From the start, effective communication played an important role in the process. "Both Jonathan and I speak Spanish," said Farias, "but cultural differences were immediately apparent. The Spanish we know is different from Paraguayan Spanish, and Ireland uses their own form of English, so it's been interesting to be exposed to these different cultures." The timing of meetings with their international clients has been challenging, too. "We have a lot of Skype conversations with both the foundation and with HP's group, and one time, we had to coordinate our meeting across four different time zones. You hear about people having these conference calls and working in global teams, but as a student you don't think of all the logistics that go into it, so it's really great exposure to have the experience, ourselves, through this project," said Ahumada.

Learning HP's custom coding was also a challenge for Jurgens and Ahumada, who were used to working with open source coding. To implement their system of data retrieval and dissemination, the team had to first master HP's way of doing things. "We're working with their engineer who is very helpful in providing information to help us figure things out on our own," said Jurgens. "We thought it would be really straightforward, but there is a lot of encryption or stuff that's been hashed somehow or provided without legends, that we've needed to decipher."

According to Silvia Figueira, computer engineering associate professor and team advisor, "That's the reality of working on projects through the Frugal Innovation Lab. Students are basically handed a problem and told, 'here you go.' This team, with their mix of computer engineering and Web design expertise is a great combination for this project, and they are learning about the realities of working with clients representing opposite ends of the spectrum—a nonprofit organization and a technology giant—as they work toward a solution that pleases everyone."

For her part, Farias especially appreciates the opportunity to help women who are supported by this project. "In Paraguay, women are considered the head of household, and they are the ones answering the survey. I love the fact that this project goes directly to women, as they are the ones most affected by poverty. After I graduate, I hope to use my skills to help women in Latin America or elsewhere."

Ahumada is also exploring the possibility of working for a company such as HP or Cisco, that have divisions working on societal challenges in Latin America. Jurgens has already lined up a job with Zuora, a Silicon Valley company that designs software to assist subscription billing for clients like Netflix. Wherever they end up, these three will bring with them a wealth of cultural, communication, and technical experience that will serve them well.

A screen shot of the team's website design for Fundación Paraguaya

FLIPPING FOR EDUCATION

More and more these days, talk in academia centers on the idea of online learning or the flipped classroom that inverts traditional teaching methods by delivering lectures or instruction online and moving "homework" into the classroom. So Laura Doyle, civil engineering academic-year adjunct lecturer, jumped right in to give it a try.

"I'd been hearing about flipping the classroom from my friends who teach at the high school level, and then at the School of Engineering faculty retreat last fall, where Dean Mungal raised the issue of hybrid education, indicating an interest in having us experiment. Since then, the topic has pretty much been in our faces, so I decided to try it for my statics class, since it doesn't have a lab but has a lot of material to cover."

Photo: Able Hsu '14

Laura Doyle (second from right) enjoys "mixing it up" in the classroom as well as in the lab.

Using Doceri, an interactive whiteboard app for iPad, Doyle recorded a lecture and posted it online in SCU's file-sharing forum. Students were assigned homework of watching the lecture and taking an online quiz. At the next class meeting, they solved problems relating to the video. "My goal in doing this is to acknowledge that every student learns differently," said Doyle. "Some like to solve problems on their own; others like to work in groups or with the teacher. Flipping the lesson gives them that opportunity and forces them to work together on problems."

In the future, Doyle plans to expand the number of lectures students watch at home and do more lab-type work in class. "I think we have to recognize that students are coming from high schools where they use iPads everyday; they are used to learning with technology in hand—this is how they've learned to learn. So when they come to college and are back to using books, it feels a bit like they are moving backwards. We need to approach this issue head-on and bring new styles of learning to the college level."

Oddly enough, this "new" style of teaching was lauded by a parent who happened to sit in on one of Doyle's flipped classes as "… a reincarnate Socrates would recognize as great pedagogy." Not a bad teaching model to follow!

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