



SANTA CLARA UNIVERSITY

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School of Engineering

engineering news

DEAN'S MESSAGE

It is a new century for the School of Engineering at Santa Clara University, and, as with any turning of the calendar page, we have lots to look back on with gratitude and much to look forward to with excitement.

We are ever grateful for the community of scholars gathered here at Santa Clara; our students' engagement with their studies and their development as citizens of competence, conscience, and compassion are inspirational as you will learn in the article, "Educating the Whole Engineer."

We are also grateful for the dedication and excellence of our faculty—a source of tremendous pride and hope for the future as they share their knowledge with the next generation of engineers here on campus and globally at research conferences as told in "Research and Outreach in Nigeria." Later this year we will say good-bye to world renowned control scientist and Professor of Electrical Engineering Dragoslav (Drago) Sijak as he retires. We are honored that Drago has spent his illustrious 47-year career with us while bringing such distinction to our program; you will find his story in this issue.

Looking forward, "new" is the byword for us as you will see in our stories about our new state-of-the-art laboratories, new faculty member, new energy scavengers, and our young computer engineering phenom who is finding new ways of creating 3D worlds for video games.

All that, and more, on the following pages. Happy reading!

Godfrey Mungal
Dean
School of Engineering

NEW STATE-OF-THE-ART LABS FOR BIOENGINEERING

The Bioengineering Program has three new laboratories, a prep room, and a new computer lab for student use and faculty research. "Students are learning by working with state-of-the-art instruments and equipment using cutting-edge technology," said Zhiwen (Jonathan) Zhang, bioengineering associate professor.

Biomolecular and Cellular Engineering Laboratory:

This wet lab features standing and desktop centrifuges, a nanodrop for biodevice engineering, sonicator for breaking cells with high frequency ultrasound, UV illuminator, FPLC protein purifier, protein separators, deep freezers, fume hood, and more. "Here, we can grow lower organisms such as *E. coli* in incubators and study them, teaching students the proper procedures and stringent rules for dealing with biohazardous materials," said Zhang.

Tissue Engineering Laboratory: This space hosts facilities for teaching and research in cell manipulation and tissue engineering; it includes two rooms outfitted to support the culture of a variety of mammalian cells including transformed, primary, and stem cells. The cleanroom is equipped with laminar flow hoods, CO₂ incubators for mammalian tissue culture, centrifuges, light and fluorescent microscopes, and -20°C and -80°C freezers. The prep room houses a microplate reader, PCR machine, and gel electrophoresis equipment for protein and nucleic acid separations.

Biomaterials Engineering Laboratory: This lab is outfitted with state-of-the-art equipment to develop and characterize biomaterial nanocomposites for end use in tissue engineering and biotechnology. General equipment includes bath sonicators for evenly dispersing nanoparticles in liquids, centrifuges, heating blocks, vortexes, shakers, and stir-plates. The lab will soon feature a rotational rheometer for mechanical characterization of biomaterial scaffolds.

Bioengineering Teaching Laboratory: A suite of computers contributes to student learning through *in silico* experiments (performed on a computer or via computer simulation). Plans for this space include a 3D biocomputational lab.

Photo: Charles Barry



Students conduct experiment with *E. Coli* in the new Biomolecular and Cellular Engineering Laboratory.

"These new laboratories provide a tremendous opportunity for enhanced collaboration between departments within the School of Engineering as well as with the Departments of Biology and Chemistry and the University's Center for Nanostructures," said Assistant Professor Prashanth Asuri.

"We encourage students to get in the labs, work with the cells, and do hands-on experiments," said Zhang. "Our goal is to have our bioengineers leave Santa Clara ready for graduate study or to begin their careers in industry with the knowledge and experience that puts them ahead of their peers. With these state-of-the-art facilities, we can do that."

"The Bioengineering program at SCU has experienced a tremendous rate of growth in recent years" said Yuling Yan, associate professor and director of the bioengineering program. "Thanks to the generous support received from the Fletcher Jones Foundation, along with that from the University and the School of Engineering, these new laboratories are now fully operational and will significantly strengthen the research training component of the BioE curriculum."

www.scu.edu/engineering/bioengineering

ENERGY SCAVENGERS



Photo: Charles Barry

From left, Aitor Zabalegui, Professor Lee, Miguel Gomez, and Rachel Reed perform research on a solar-powered cook stove.

Usually, the word “scavenger” conjures up negative images of dirty dumpster diving or creepy vultures awaiting their turn at the fallen lion in the Serengeti, but our own Hohyun Lee, assistant professor of mechanical engineering, is part of a new breed of energy scavengers that is putting a positive spin on the term.

From investigating ways of providing residential consumers with the efficiency of solar thermal energy to developing a health monitoring system powered by the body’s own heat, Lee is tackling the challenges of thermal energy harvesting.

“When talking about solar energy, people usually think about PV [photovoltaic panels] converting light to electrical energy and then converting electricity into thermal energy. Using solar thermal energy directly makes more sense when thermal energy is the final form of application, such as for heating. We know we can generate electricity from solar thermal by using a turbine—that’s been proven with huge concentrated solar thermal plants. But solar thermal has not

yet been effectively put to use on a smaller scale, so my students and I are working on adapting the technology for residential use,” Lee said.

In addition to harvesting solar thermal energy, Lee also seeks ways of putting wasted heat to use. “More than half the energy produced—up to 60 percent—is wasted heat,” said Lee. “If we can recover wasted heat effectively, we can reduce fuel consumption by at least 30 percent.”

To this end, Lee is working on generating power from the human body using material with highly efficient thermoelectric properties. “I’m running projects with students this year trying to harvest energy to power a health monitoring system that will send information to a cell phone or health care provider. The undergraduates are researching how to optimize the process of obtaining power from the thermoelectric modules, and graduate students are doing modeling work to provide theoretical support,” he said.

Another student project for harvesting thermoelectric energy involves a cook stove. “Wasted heat from the cook stove can be used as a local power source in off-grid communities,” Lee reports. Still more student teams are working on a number of other energy scavenging projects for developing countries, including a water purification system, neonatal incubator, and even a chicken brooder.

Not content with following just these avenues for energy harvesting, Lee and his student scavengers are also busy working on energy storage, solar tracking systems, efficient building materials, and more.

HISHAM SAID JOINS CIVIL ENGINEERING FACULTY

Today’s civil engineer faces a seemingly limitless number of decisions in completing a project. Questions of safety, cost, sustainability, and scheduling make for a daunting task. But with his background in structural engineering and his research in computational and quantitative methods for optimizing construction operations and civil infrastructure systems, Hisham Said, civil engineering’s newest faculty member, is just the one to help students take on this Herculean mission.

“Civil and construction engineers deal with huge problems that have millions, or even billions, of potential solutions,” he said. “But by using optimization and simulation algorithms, engineers can quickly and intelligently make informed decisions on anything from managing onsite logistics during construction to designing for specific levels of LEED certification.”

Mark Aschheim, chair of civil engineering, welcomes Said’s arrival, noting growing student interest in construction and the increasing importance of management of the construction supply chain, as the use of computerized building information models become more pervasive.

Said will be teaching a class on sustainable construction as well as another course, Engineering Business

and Economics (CENG 208) that will bring civil engineers together with students participating in the Sustainable Energy master’s degree program. “I am excited about this new collaborative course,” he said. “It is an innovative approach that will give students the skills they need to analyze the types of financial decisions they may face in their careers.”

According to Said, Santa Clara’s collaborative environment was a big draw for him, as were SCU’s Jesuit tradition and focus on teaching. “Here, you feel something unique, because there is a strong commitment to academic excellence and a philosophy of teaching students to be of service to the community. The aim is to connect students with how they can use what they have learned to serve the good—that is a unique mixture.”



Photo: Nicole Morales

DRAGOSLAV SILJAK TO RETIRE FROM THE DEPARTMENT OF ELECTRICAL ENGINEERING



Dragoslav Siljak, world-renowned control scientist and professor of electrical engineering at SCU for the past 47 years, has announced he will retire at the end of the academic year.

In 1964, the former Olympic athlete (silver medal as part of Yugoslavia’s 1952 water polo team, and World Cup in 1954), Ph.D., and docent professor from the University of Belgrade, Serbia, accepted then-dean Robert Parden’s invitation to join the faculty

as a visiting professor to teach courses in electrical engineering and applied mathematics, attract grants to strengthen research in the department, and structure the electrical engineering Ph.D. program.

Joining reputable control scientist and SCU lecturer Dr. George Thaler and Professor Richard Dorf, department chair, the three formed a research group in control systems and soon received a grant from the NASA Ames

Research Center to develop new methods for control design of space vehicles. Siljak was invited by the control group at NASA’s Marshall Space Center to apply the methods to stability analysis and control design of the Saturn V rocket that propelled men to the moon.

In the 1970s, he initiated research in the theory and application of complex large-scale dynamic systems, which he applied to a variety of models in

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COMPUTER ENGINEERING JUNIOR CHANGES THE LANDSCAPE OF 3D GRAPHICS

Photo: Nam Ling



John Judnich presents his research at top conference in computer graphics.

John Judnich, a junior computer science and engineering major, has had a goal in mind for some time: "I want to create an entire 3D world for video games with billions of stars, planets, and nebulae, where the user can explore all that not just from afar, but fly into a planet and see mountain ranges, fog, and sunsets...entire cities of homes and buildings and forests that can be experienced from the ground level."

Working toward his goal, Judnich found computers were too slow to create the millions of trees he envisioned, so he took it upon himself to solve the problem and reinvented an algorithm for an existing technique used for drawing games and simulations, making it faster, more flexible, and more efficient—improving overall performance by 50 percent. "When I first considered the idea, I thought, 'this is a fun technique and it works well, too; it's probably been done already.' But I looked through the journals and couldn't find anything on it, so it was pretty exciting."

Supported by a grant from the Carmen A. and Jack D. Kuehler Undergraduate Engineering Research Fund, Judnich began research with Nam Ling, professor and chair of the Department of Computer Engineering, which resulted in his paper, "Fast Multiresolution Terrain Rendering with Symmetric Cluster Sets," being accepted into ACM SIGGRAPH Asia 2011. Judnich was a 19-year-old sophomore when the paper was

submitted in competition with Ph.D.s and graphics experts worldwide to this Number 1 top conference in computer graphics. "I had no idea I'd get into the conference, and I didn't expect it because they have a very low acceptance rate," he said; but recently he found himself in Hong Kong presenting his work before the elite audience.

All this is quite an accomplishment for someone who purchased his first used computer when he was in middle school. "Before I had a computer, I would buy IBM programming manuals at the thrift store and study them. That way, I was ready when I could finally get started," he said.

Judnich's innovation and skill have made him an attractive recruit with industry leaders. Last summer he interned at NVIDIA, and Microsoft has already snagged him for an internship next summer.

"A student like John Judnich comes around about once every 10 years; he really is a genius at what he does," said Ling. "Silvia Figueira, associate professor of computer engineering, discovered his unique talent in her class and introduced him to work with me," he added. But Judnich, who is humble about his work, said, "I never knew that what I did was special, and maybe I'm still in denial, but I really believe anyone can do well if they study. If you find something fascinating, research it to death and keep working at it."

RESEARCH AND OUTREACH IN NIGERIA

Two School of Engineering professors traveled to Nigeria recently to present keynote speeches at the 3rd IEEE International Conference on Adaptive Science and Technology. While there, they also visited a local high school in Abuja—Loyola Jesuit College—headed by principal and SCU alumnus Ugo Nweke, S.J. '10.

At the conference, Tokunbo Ogunfunmi, associate professor of electrical engineering and associate dean for research and faculty development, presented "Talk Is Cheap: Advanced Speech Processing Is Here." His talk provided an explanation of how most modern-day speech coding works and offered his group's recent research results and solutions for enhanced performance to packet switch network problems commonly experienced with Internet programs such as Skype and Google Talk.

Nam Ling, chair and professor of computer engineering, presented "Video Compression: A New Era." Ling and his doctoral students contribute heavily, and regularly compete with large corporations in creating the international standard for the next generation of video compression.

The conference, which brought together researchers from academia and industry from both developed and developing countries, afforded a glimpse into what is on the minds of colleagues in the West African sub-region. "There is a lot of interest in forensic security of computers in Nigeria, and there is also lots of interest in energy," said Ogunfunmi.

They found this to be true for the high school students, as well. Loyola Jesuit College strives to be self-sustaining as they raise their own food and generate their own power for the 663 live-in students. "Visiting the school was the highlight of our trip," both agreed. "We talked with the students about SCU and the programs we offer, and encouraged them to apply," said Ling. "We are also investigating ways for Santa Clara students to partner with this school. We would love to see some of our engineering students spend a summer at the high school, helping to build an effective computer infrastructure on campus and perhaps teaching some classes," said Ogunfunmi.



Photo: Godfrey Mungai

From left, Tokunbo Ogunfunmi, Fr. Ugo Nweke, and Nam Ling pose in front of a statue of St. Ignatius of Loyola at Loyola Jesuit College in Abuja, Nigeria.



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www.scu.edu/engineering/100



SOLAR DECATHLON

SCU SELECTED FOR 2013 SOLAR DECATHLON

Following our successes in the 2007 and 2009 contests, Santa Clara has been selected as one of 20 teams to compete in the prestigious international competition sponsored by the U.S. Department of Energy.

Read more:

www.scu.edu/engineering/solar

EDUCATING THE WHOLE ENGINEER



Felipe Yerkes Medina (third from left) enjoys creating community with fellow undergraduates while leading spiritual retreats.

The School of Engineering boasts a 100-year history of "educating the whole person" in keeping with our Jesuit tradition. One way this happens is through student involvement with Campus Ministry (CM) programs.

Claire Kunkle '14 (mechanical engineering) is a music ministry intern. "So much of the college experience is expanding your horizons

and being involved in many different facets of university life," she said. "Campus Ministry is one of my most rewarding. I get personal fulfillment through my relationships there and I get to grow as a person as well."

Felipe Yerkes Medina '12 (civil engineering), retreat leader and CM intern, agrees: "I have experienced a lot of the heart and the community that Santa Clara has to offer here... a group of people who care about what you study, but also really put a heavy emphasis on the whole person, *cura personalis*; they really want to make you into a well-rounded person."

Campus ministers note how aware engineering students are of the positive effect their expertise can have on society. Ashley Ciglar '12 (civil engineering) is a good example: "During my sophomore year I was a CM intern under Social Justice Ministry. I was able to increase my knowledge about current and past social justice issues...and reflect on my vocation through retreats and one-on-one dialogues," she said.

Mike Sizemore '12 (mechanical engineering), eucharistic minister, says CM is "a place where many people of different backgrounds can come together, share experiences, and socialize. This has helped orient my social life and life goals to a place that I am proud of."

Graduate engineering students also make good use of CM, and a small faith-sharing group is being formed among them this quarter, facilitated by Society of Jesus members Fr. Manh Tran, director of the Christian life community, and Fr. Jim Reites, associate professor of engineering by courtesy.

With the help of Campus Ministry, the School of Engineering will continue its rich tradition of educating the whole engineer well into its next century.

Read an expanded version of this article: www.scu.edu/engineering/news/2012winter

SILJAK TO RETIRE...

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areas as diverse as electric power systems, large space structures, population biology, the arms race, and competitive equilibrium in mathematical economics. Over the years, the research has involved a large number of scientists and engineers from all over the world, who came to Santa Clara to study complex dynamic systems. The projects have been generously supported by NASA, NSF, DOE, and DARPA.

A prolific scholar, Siljak has published four books: *Nonlinear Systems* (Wiley, 1969), *Large-Scale Dynamic Systems* (North-Holland, 1978), *Decentralized Control of Complex Systems* (Academic Press, 1991), and *Control of Complex Systems: Structural Constraints and Uncertainty* (Springer, 2010, with fellow SCU Electrical Engineering Professor Aleksandar Zecevic), and more than 200 papers in scholarly

and scientific journals. The book on large-scale systems was reprinted in 2007 as a classic text by Dover Publications, and Siljak's book on decentralized control was posted on Amazon as #1 in demand in the two areas—control systems and information theory; a used copy of this book has fetched more than \$800.

In 2010, Siljak received the Richard E. Bellman Control Heritage Award for his achievements in control theory. The award is given by the American Control Council for "distinguished career contributions to the theory or applications of automatic control" and it is the "highest recognition of professional achievement for U.S. control systems engineers and scientists." Siljak is a Life Fellow of IEEE.



The Jesuit University in Silicon Valley