

ARCE

ARCHITECTURAL ENGINEERING DEPARTMENT | COLLEGE OF ARCHITECTURE AND ENVIRONMENTAL DESIGN | SUMMER 2019



PROFESSOR JAMES MWANGI'S GLOBAL REACH



CAL POLY



Department Head Al Estes

DEPARTMENT HEAD'S MESSAGE

Activity Abounds In ARCE

WELCOME TO THE LARGEST edition of the annual ARCE magazine ever published. We have been incredibly busy this past year, and it simply took more pages to tell the story. This issue is filled with news about global adventures, faculty research, a cool faculty sabbatical, creativity in the classroom, involvement with industry, student competitions, facilities upgrades, social events, and generous support from those who believe in this program. So read on, and discover how we spent the past year.

I want to thank Buehler Engineering, the prominent Sacramento-based structural engineering firm, for sponsoring this edition. It has hired numerous Cal Poly architectural engineering (ARCE) graduates over the years, has worked on complex and interesting projects, and is profiled at the end of the magazine.

We welcome Jamie Budd to the administrative staff and congratulate ARCE faculty member John Lawson for his promotion to professor. I also congratulate faculty member Anahid Behrouzi for winning the ExCEED teaching award, Craig Baltimore and James Mwangi for obtaining a patent, and Ed Saliklis for publishing a textbook.

My proudest moment this year came at graduation with the university award of a posthumous degree to Carson Starkey, an ARCE freshman who died in 2008. His parents, Scott and Julia Starkey, have supported this program in a variety of ways despite enduring a parent's worst nightmare. The entire family was on stage when Carson was inducted into the Order of the Engineer at the department ceremony.

ALLEN C. ESTES | DEPARTMENT HEAD
ARCHITECTURAL ENGINEERING



CAED Dean Christine Theodoropoulos

DEAN'S MESSAGE

Building Momentum With Your Support

THIS HAS BEEN a great year for the Architectural Engineering Department. Such accomplishments could never have come from state dollars alone. Support for the program has come in the form of laboratory sponsorships, scholarships, Instructionally Related Activity grants, course sponsorships, and gifts to the Architectural Engineering Fund for Excellence. I am particularly proud of the Parents Learn by Doing Fund, which is profiled in this magazine. Thank you to the alumni, friends, industry partners, parents and other Cal Poly supporters.

As I enter my seventh year as dean of the College of Architecture and Environmental Design, I remain proud of our college. I salute the faculty and staff who have created a wonderful learning environment for our students. As part of the college's strategic plan, we continue to expand student leadership opportunities; increase interdisciplinary experiences; and create a program of technology, tools and methods instruction.

CHRISTINE THEODOROPOULOS, AIA, PE | DEAN
COLLEGE OF ARCHITECTURE AND ENVIRONMENTAL DESIGN

IN THIS ISSUE

- 04** THANK YOU, DONORS
- 06** STUDENT ACHIEVEMENT
- 10** EVENTS & ACTIVITIES
- 12** LEARN BY DOING
- 14** STUDENT RESEARCH
- 18** EXPERIENCES ABROAD
- 33** FACULTY ACHIEVEMENT
- 36** FACULTY & STAFF NEWS
- 38** ALUMNI NEWS
- 41** INDUSTRY PARTNERS

ON THE COVER

Architectural engineering Professor James Mwangi (center) conducts a wall construction workshop in the Philippines as part of a fellowship program established by Build Change and Simpson Strong-Tie. The mission: to help developing countries build safer structures. Read about Mwangi's experiences in the Philippines, Colombia and Indonesia on Pages 22-27.

THIS PAGE

Students participating in the Cal Poly-University of Auckland Research Fellowship program gain valuable research experience, and on days off, enjoy New Zealand's breathtaking natural beauty. Program participant Ryan Schwartz (below) takes a break from studies at Cathedral Cove. Read more on Pages 28-32.

ARCE MAGAZINE

Your content contributions are welcome for this annual publication. Please contact Jamie Budd at arce@calpoly.edu or 805-756-1314.

Content Manager: Department Head Al Estes

Project Coordinators: Erika Clements and Jamie Budd

Writer: Jo Ann Lloyd

Designer: Shirley Howell

Photography: Josef Kasperovich; courtesy photos

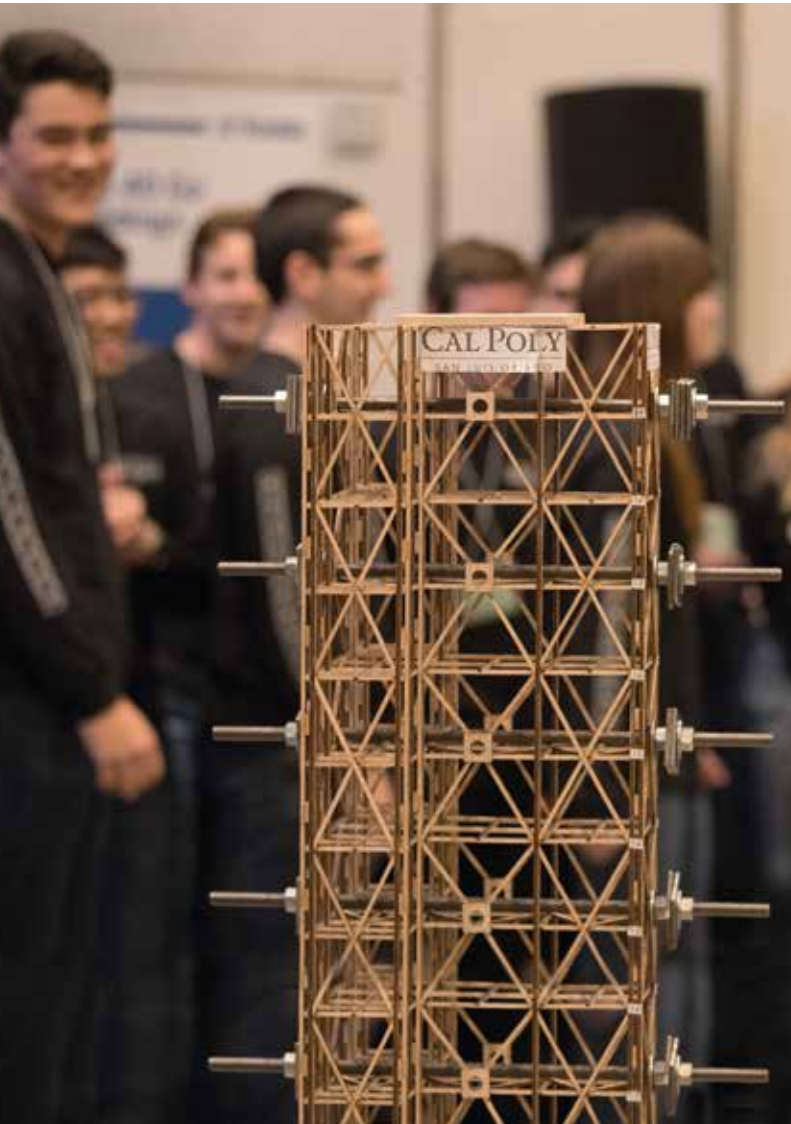
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STRUCTURAL SUPPORT

**PARENTS LEARN BY DOING FUND
STRENGTHENS ARCE PROGRAM,
ENHANCING STUDENT EXPERIENCE**



SUPPORTING STUDENT ACTIVITIES. Updating labs. Assisting student research and senior projects. Supplementing travel costs to conferences, workshops and competitions. Funding student awards.

All that costs money — money not typically provided in the state-allocated budget. But all of those activities have been made possible, at least in part, thanks to the generosity of parents and the Architectural Engineering (ARCE) Department's Parents Learn by Doing Fund (PLBDF).

"I am amazed at how we have been able to augment the ARCE student's educational experience with these gifts," said Department Head Al Estes.

The first phase of the fund was established years ago, when Florian and Lori Barth, parents of then-student Ian Barth (ARCE, '14) donated \$50,000 with the caveat that other parents match their contribution, dollar for dollar. That \$100,000 goal was met quickly, and the effects were immediate.

Estes is taking a different approach for a second \$100,000 campaign. He is recruiting five parents to each donate \$10,000, with matching gifts from other parents and supporters in whatever increments they can afford. Parents who contribute at least \$250 will be recognized on a plaque.

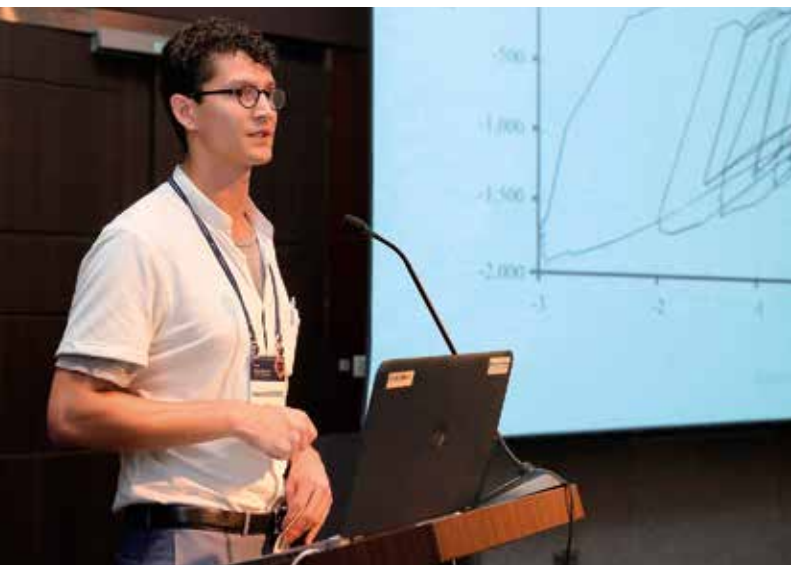
Three sets of parents have stepped forward: Samir and Madalyn Rustagi, Dan and Debra Hall, and Ken and Jeanne Stone.

"Donating to the PLBDF is the most direct way to give to the department," Estes said.

Increasingly, students are aiming to present the results of their senior and master's projects at conferences and have them published. The ARCE Department has sent over a dozen undergraduates and graduate students to present their research findings at conferences as far away as Germany and Korea.

The fund has covered the cost of materials for senior projects and master's theses, including efforts by students Rory de Sevilla and Jerry Luong to build and test a non-ductile concrete wall in the High-bay Lab. (*See related article, Page 15*).

LEFT: ARCE students' participation in the EERI Seismic Design Competition is made possible by the Parents Learn by Doing Fund.



MADE POSSIBLE BY THE FUND ...

- Student travel to Vancouver, Canada, to compete in the Earthquake Engineering Research Institute Seismic Design Competition (see *related article, Page 9*), as well as student travel to the Architectural Engineering Institute Workshop for Student Chapter Leaders in Tysons, Virginia.
- Faculty creativity in the classroom, such as the interdisciplinary studio, where faculty members Ed Saliklis (ARCE) and Clare Olsen (Architecture) lead students in the design and construction of shell structures.
- A field trip to Weed, California, for the interdisciplinary studio taught by Dennis Bashaw (ARCE), Maggie Kirk (Architecture), and Greg Starzyk (Construction Management) that focused on the community's recovery from a fire.
- Steel and accessories for a student project led by ARCE Assistant Professor Michael Deigert to build and test a full-scale moment frame as part of the Steel Design Laboratory.
- Computer tablets to fulfill select faculty members' request to experiment with this technology in classes.
- Improvements to laboratory equipment, including load cells, control boxes, software and accelerometers to support various student projects and classroom exercises.

The PLBDF is supporting de Sevilla's attendance at the annual conference of the Structural Engineers Association of California in August in Squaw Valley, where he will present a paper on the research results. The fund will also support students Sydney Gallion and Abby Lentz, who will present papers at the same conference. In addition, the travel costs of undergraduates Tomlinn Cox, Tia Kelly, Douglas McArthur and Nolan McWhorter will be supplemented so they may attend the conference.

Every ARCE senior and every incoming student benefits from the PLBDF. "We present commemorative gifts to every student who attends Senior Banquet," Estes explained. "We cook lunch for all incoming freshmen during WOW week and give them an ARCE T-shirt. The fund covers the cost of our Parent's Weekend reception and annual Scholarship Luncheon."

The list of items the fund has supported goes on and on. The need for the fund does too.

"This fund allows us to enrich the hands-on learning that Cal Poly is known for," Estes said. "Nobody has a more vested interest in the success of this program than the parents who entrust their sons and daughters to our care. I will continue to encourage them to contribute and be a critical part of this program." ■

TOP TO BOTTOM: The fund supports: Assistant Professor Michael Deigert's Steel Design Laboratory; attending conferences, such as student Alexi Kouromenos' trip to South Korea to present a paper; and a studio involving design and construction of shell structures.



Former architectural engineering student Carson Starkey.

In His Honor

CARSON STARKEY'S PARENTS ACCEPT DEGREE ON 10TH ANNIVERSARY OF THEIR SON'S DEATH

THIS YEAR'S COMMENCEMENT ceremony, an already-emotional occasion for graduates and their families, featured an especially meaningful moment when Cal Poly awarded Carson Starkey, an architectural engineering (ARCE) freshman who died in 2008, a posthumous degree.

The ARCE Department also posthumously inducted Carson into the Order of the Engineer. His parents, Scott and Julia Starkey, received the certificate and ring on Carson's behalf. Carson's brother, Hayden, was also present with his wife, Laura, and daughter, Madeline.

"Carson was a freshman in the ARCE program in December 2008, when he died from acute alcohol poisoning at a fraternity incident," said ARCE Department Head Al Estes. "This year recognizes the 10th anniversary of Carson's death, and this degree will hopefully bring honor, closure and a statement of Cal Poly support to his parents."

Despite their pain, Scott and Julia Starkey embraced the Cal Poly community and dedicated the last 10 years to ensuring that a similar fate does not happen to other young students. They founded Aware Awake Alive, an organization focused on preventing loss of life to alcohol poisoning.

The Starkeys have also established four \$1,250 annual scholarships for current ARCE freshmen.

The ARCE 106 freshman introduction course (*see related article, Page 13*) is dedicated in Carson's honor. "The class of 2019 was the first to take ARCE 106 as freshmen, so it was even more moving that they welcomed Carson as their classmate," Estes said.

"Scott and Julia are the ideal role models for demonstrating how to turn a parent's worst nightmare into something positive, generous and redemptive," Estes continued. "On behalf of the ARCE Department, I can think of no better way to honor their son's memory than to award him a posthumous degree on the 10th anniversary of his death."

In all, 59 ARCE undergraduates and 10 master's degree students attended commencement on June 15 in Spanos Stadium. Before the official graduation ceremony, the annual Barrish Pelham Order of the Engineer Ceremony was held in the Hasslein Courtyard, where each graduate received a stainless steel ring, took an oath, and was presented with a certificate.

"The ring is placed on the graduates' pinkie finger of the working hand to remind them that the safety of the public is at stake whenever they sign a design drawing," Estes said. ■



ABOVE: ARCE Department Head Al Estes presents the Starkey family with a certificate and ring signifying the honorary induction of Carson Starkey into the Order of the Engineer.

LEFT: With Al Estes, Julia and Scott Starkey awarded the Carson Starkey Scholarship to students (from left) Garrett Barker, Justine Teoh and Paulina Robles.



Art Ross claimed the ARC'Y statuette in 2014 for CYS, and Amy Hackney won the award in 2018 for SGH.

AND THE ARC'Y GOES TO ...

THE ARCHITECTURAL ENGINEERING (ARCE) Department awarded its annual ARC'Y Award to the structural engineering firm of Simpson Gumpertz & Heger (SGH) for best video shown at the ARCE Department's annual Scholarship Luncheon. This is the firm's third consecutive ARC'Y Award.

The award was created in 2013 in recognition that most scholarship donors would have to travel too far to present their scholarship at the one-hour event. As an alternative, the department invited the firms to submit a short video congratulating the awardee on behalf of the sponsoring firm. Just like the Oscar or the Emmy, the ARC'Y Award recognizes the best in entertainment filmmaking in any given year.

"Many firms participate, and the Scholarship Luncheon is enlivened and personalized as a result," said Department Head Al Estes. "But only the best entries can win the coveted ARC'Y Award."

ARC'Y WINNERS TO DATE

2017, 2018 and 2019 — SGH

2015 and 2016 — Degenkolb

2013 and 2014 — CYS

See the winning videos from each year at: <https://arce.calpoly.edu/arce-award>. ■

Just Rewards

2019-20 SCHOLARSHIP RECIPIENTS ANNOUNCED

EVERY YEAR, the Architectural Engineering Department bids a fond farewell to its graduating seniors while also rewarding some deserving students with scholarships. We are proud of all ARCE students for successfully completing another year of vigorous scholarship, and we congratulate those who have demonstrated excellence above and beyond the major's rigorous curriculum. The student scholarship recipients listed here are being rewarded for their tenacity and dedication. A total of \$137,146 in scholarships was awarded for the 2019-20 academic year.

COLLEGE OF ARCHITECTURE AND ENVIRONMENTAL DESIGN SCHOLARSHIPS

Castagna Scholarship (\$15,000 each) — Nicole Buck, Emmanuel Corona-Navarro, Tracy Doan, Lilliann Lai, Tony Nguyen, Faith Sharp and Jenna Williams

Herbert E. Collins Scholarship (\$1,800 each) — Sophia Ha and Autumn Wagner

Robin L. Rossi Award (\$1,000 each) — Tomlinn Cox and Iryna Turchyn

ARCHITECTURAL ENGINEERING DEPARTMENT SCHOLARSHIPS

Emanuele Barelli Structural Engineering Scholarship (\$900) — Joshua Shockey

Eugene E. Cole S.E. Senior Project Award (\$3,000 total) — Elyssa Adams and Nicholas Dekker

Degenkolb Engineers Scholarship and Internship (\$2,375) — Teagan Allen

Fluor Foundation Scholarship (\$1,050) — Douglas McArthur

Forell/Elsesser Engineers Scholarship (\$1,000) — Ryan Millward

Paul F. Fratessa Memorial Scholarship (\$1,000) — Dolores Herrera

KNA Consulting Engineers Senior Project Scholarship (\$1,500 total) — Maxwell Chamberlain, Christian Jones, Lilliann Lai, Nathan Mok, Corbin Morisada, Ramsey Othman and Nathan Woo

KPFF Los Angeles / Pasadena Scholarship (\$1,500) — Chase Stewart

John Labib and Associates Scholarship (\$1,425 each) — Michael Ayers and Marin Govett

John A. Martin and Associates Scholarship (\$1,500) — Ryan Schwartz

Hans Mager Scholarship (\$1,200) — Alejandra Bravo

Simpson Gumpertz & Heger Inc. Scholarship (\$4,750) — Nicholas Slavin

Carson Starkey Scholarship (\$1,250 each) — Garrett Barker, Adria Burton, Paulina Robles and Justine Teoh

OUTSIDE SCHOLARSHIPS

CMACN Engineering Scholarship (\$750 each) — Ceiley Davis, Riley Denis, Marin Govett and Doug McArthur

Structural Engineers Association of Southern California Scholarship (\$2,500) — Bryce Gagner

Structural Engineers Association of Northern California Scholarship (\$5,000) — Elyssa Adams



LEFT: ARCE Department Head Al Estes congratulates Fluor Foundation Scholarship recipient Douglas McArthur.



IT'S A FIRST!

ARCE TEAM WINS TOP HONORS AT INTERNATIONAL SEISMIC DESIGN POSTER COMPETITION

CAL POLY ARCHITECTURAL engineering (ARCE) Assistant Professor Anahid Behrouzi traveled with 15 members of Cal Poly's Earthquake Engineering Research Institute (EERI) Seismic Design Competition (SDC) Team to Vancouver, Canada, where the team won first place in the poster section of the contest.

Cal Poly's team also earned a ninth place overall, and its architectural concept ranked third.

In all, 38 teams competed, representing universities in Canada, China, the Dominican Republic, Ecuador, Egypt, Romania, Turkey and the U.S.

Teams are judged on the performance of their five-foot-tall balsa wood model when it's subjected to two earthquake ground motions; the accuracy of students' computer simulation predictions as compared to measured results; and their technical communication via written proposal, poster and oral presentation.

This marked the first time in the international competition's 16-year history that it was held outside the United States. The weeklong contest is part of EERI's annual meeting, held this year in March.

The first-place poster was prepared by ARCE students Tomlinn Cox, Julia De Hart, and team captain Jenna Williams. Additional ARCE students who competed include Nick Coburn,



TOP: ARCE students and their faculty advisor, Anahid Behrouzi (second from right), react to their structural model's performance during the maximum earthquake shake test.

ABOVE: The students' poster took first place in the competition.

Allie Decker, Riley Denis, Michael Goldenberg, Sophia Ha, Ryan Millward, Tony Nguyen, Maja Sagaser, Jay Skaff, Nick Slavin, Ryan Thornton and Autumn Wagner.

Behrouzi, the faculty advisor to the student team, presented a poster during the conference titled "Improving Ductility of Reinforced Concrete Walls with FRP Sheets and Splay Anchors."

"It is invigorating to mentor a team that works so tirelessly on the design, construction, analysis and testing aspects of the EERI SDC competition — skills that equip the students as future structural engineers," Behrouzi said. "Beyond that, their success this year in poster and architectural design speaks to the well-rounded ARCE training. Vancouver was an exciting time for Cal Poly EERI, and we eagerly await San Diego in 2020!" ■

Opportunities Knock

29TH STRUCTURAL FORUM PRESENTS CAREER OPTIONS 'FROM THE GROUND UP'



MORE THAN 200 STUDENTS attended the 29th annual Structural Forum in February, hearing industry insiders talk about careers outside the regular structural design consulting world. The event theme, "From the Ground Up," aimed to inspire individuals to explore the variety of opportunities in the structural engineering field.

"This year's forum capitalized on the unique paths available in the industry," said fourth-year architectural engineering (ARCE) student Jenna Williams, SEAOC (Structural Engineers Association of California) Structural Forum chair. "The speakers talked about finding something within structural engineering that helped them pursue their passions."

Keynote speaker Evan Reis, co-founder of the U.S. Resiliency Council, talked about the development of resiliency in the field and how industry professionals and students can help promote and grow resiliency in the workplace and in academic communities.

In addition, Amber Freund spoke about her journey to becoming the CEO of the structural engineering software corporation RISA; Sinéad Mac Namara, joint professor in the College of Architecture and College of Engineering at Syracuse University, talked about her research on the collaboration between architecture and engineering students at Syracuse; and Kit Miyamoto, CEO of Miyamoto International, discussed his work helping Third World countries rebuild after earthquakes.

For Williams, the learning started before the presentations began.

"You learn valuable lessons planning such a large event," she said. "You can never be too prepared or start too early. Still, some things are out of your control, so be ready to accommodate changes. And thank your supporters. It took 26 students to create Structural Forum. Let people know their effort is appreciated."

Williams said her hard work was rewarded by giving classmates an opportunity to network with professionals.

"Structural Forum helps empower students to find the path that is right for them. I'm fortunate that I was able to assist my friends and colleagues in exploring career options."

Department Head Al Estes called Williams "one of those students with exceptional time management and leadership skills. She gets involved in everything," Estes said. "Forum was terrific this year. I want to thank the students, our guest speakers, and the 54 companies that supported the event." ■

LEFT: Keynote speaker Evan Reis, U.S. Resiliency Council co-founder, encourages professionals and student to develop resiliency in the industry and on campus.

BELOW: Architectural engineering students Nick Slavin (left) and Rachel Keith talk with a company representative at the Structural Forum career fair.





LEFT: Maya Sneller (ARCE, '98), a representative for Rinne & Peterson, connects with a potential employee.

BELOW: Structural Forum Chair Jenna Williams is recognized for coordinating a successful event.



PARTICIPATING COMPANIES

ARCE thanks the 54 companies that made the 29th annual Structural Forum a success.

Advanced Structural Design Inc.
 Ashley & Vance Engineering
 Barrish Pelham, a Degenkolb Company
 Biggs Cardosa Associates
 Brandow & Johnston
 Brooks Ransom Associates
 Buehler Engineering Inc.
 Clark Pacific
 Coffman Engineers
 Cornerstone Structural Engineering Group Inc.
 DCI Engineers
 Degenkolb Engineers
 DES Architects + Engineers
 DeSimone Consulting Engineers
 Englekirk Structural Engineers
 4 S.T.E.L. Engineering Inc.
 Gessner Engineering
 Harris & Sloan Management Inc.
 Hohbach-Lewin Inc.
 Holmes Structures
 IDA Structural Engineers
 JCE Structural Engineering Group Inc.
 John Labib & Associates
 KNA Structural Engineers Inc.
 KPFF
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 Mesiti-Miller Engineering
 MHP Inc. Structural Engineers
 Miyamoto International Inc.
 MKM & Associates
 MWA Inc.
 Nishkian Menninger
 Nous Engineering
 PARADIGM Structural Engineers
 Peoples Associates Structural Engineers Inc.
 Rinne & Peterson Inc.
 Rutherford + Chekene
 SidePlate Systems Inc.
 Simpson Gumpertz & Heger
 Simpson Strong-Tie
 Stantec
 STB Structural Engineers
 Strandberg Engineering
 Structural Engineers Incorporated
 Summit Engineering Inc.
 Taylor & Syfan Consulting Engineers Inc.
 TEECOM
 TKJ Structural Engineering
 Tuan and Robinson Structural Engineers
 Watry Design Inc.
 Wiss, Janney, Elstner Associates Inc.
 ZFA Structural Engineers

LEARN BY DOING



TOP: Simpson Strong-Tie's Darwin Waite assists students Nicholas Grover Gazdak and Cammie Grant in constructing a timber connection.

ABOVE: A student (right) gets a welding lesson from CAED Shop Manager Dave Kempken.

RIGHT: Karina Rosales drills into concrete to place a Hilti bolt.



OUR FRESHMEN EMPOWERED

ARCE 106 — DEVELOPED IN HONOR OF A FORMER STUDENT —
ENGAGES ARCE MAJORS EARLY IN THEIR COLLEGE EXPERIENCE

This year's architectural engineering (ARCE) graduates share a unique experience: They were the first students to have taken ARCE 106: Introduction to Building Systems, a course designed in honor of deceased student Carson Starkey and one intended to give first-year students a sense of what to expect as undergraduates.

Starkey was an ARCE student who died in 2008 during his freshman year. His death spurred the creation of the course.

"We pride ourselves on knowing nearly every one of our ARCE students," said Professor John Lawson, who co-created and co-teaches the class with Department Head Al Estes. "However, as a freshman, Carson was not known to us."

Starkey's death brought the realization that ARCE faculty members didn't get to know their students until their sophomore year, when they take their first structures courses. The department also wasn't exposing first-year students to the broader picture of architectural or structural engineering.

"Freshmen didn't see any architectural engineering courses until their second year," Lawson said. "Al and I saw the opportunity to create a freshman experience course that all ARCE's could take together."

"We were thinking of Carson, because he never made it past his first year, never got to know us, and we never got to know him," Lawson continued. "Now we have a course that allows us to spend time getting to know all freshmen in the smaller activity groupings that occur weekly."

As a freshman in 2015, Karina Rosales (ARCE, '19) was a member of that first ARCE 106 course.

"We knew the course was created to honor Carson Starkey," Rosales said. "His parents, Scott and Julia Starkey, actually came to talk to us — to tell us what had happened to their son and why it was important that they start ARCE 106."

During the hands-on course, students are introduced to structural systems of wood, steel, concrete and masonry, as well as to architectural enclosure systems, civil earth and foundation systems and mechanical, electrical and plumbing systems.

"The class was valuable to me as a freshman for several reasons," Rosales said. "Early in my academic career, I was



ABOVE: Students Addie Albro (left) and Kate Robinson secure a wooden connection under the supervision of Simpson Strong-Tie's Tyrone Streeter.

able to study a variety of topics, which gave me a better understanding of what ARCE entailed. Additionally, because the class was interactive, it was easy to make friends. It definitely made me feel more welcome and helped me unite with my peers as we were all trying to adjust to our new college lifestyle in a major that is known to be challenging."

Rosales also noted that during the first week of class, Lawson and Estes took a picture of every student so they could learn the students' names early on.

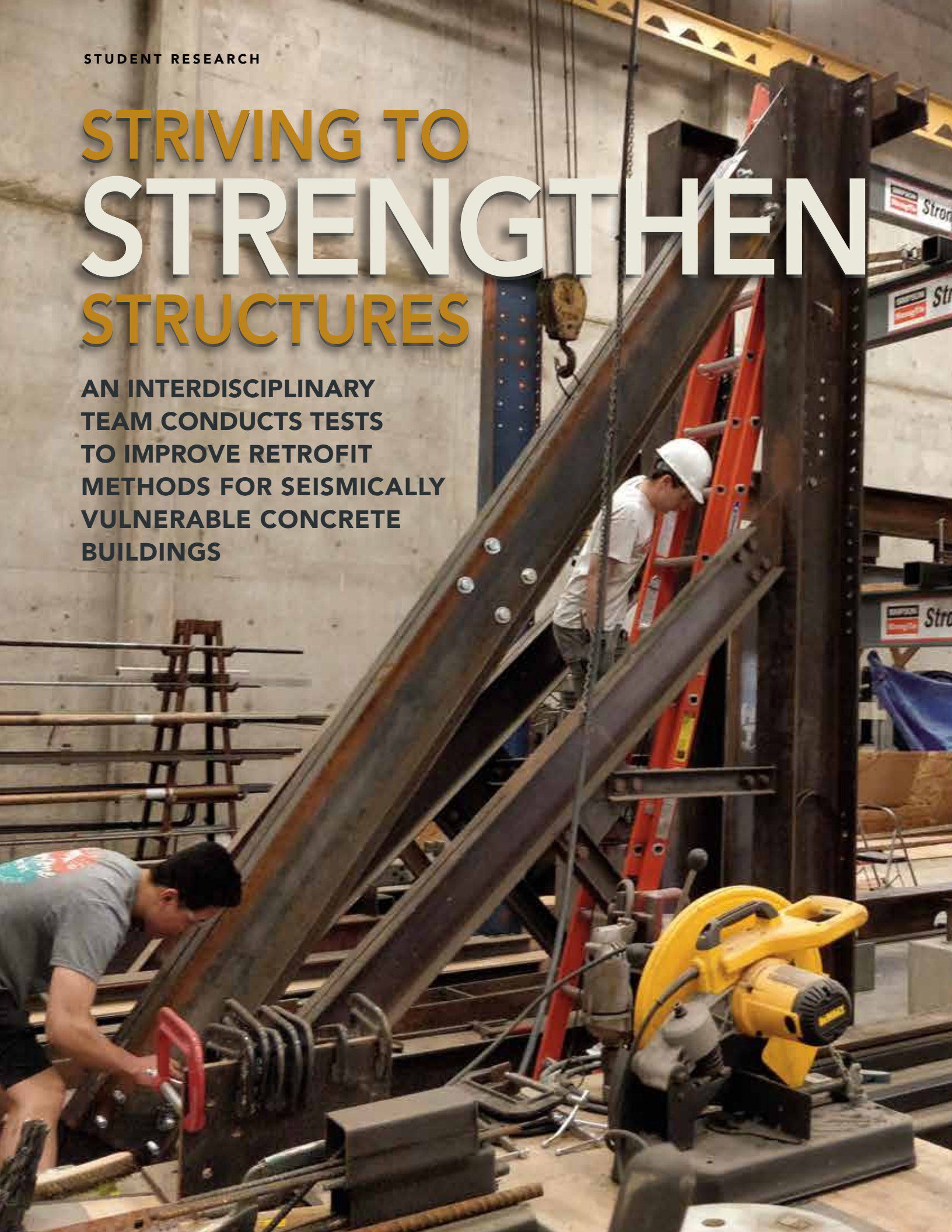
"I think that says a lot about the department and how the faculty genuinely care about their students," she said.

Watch a video and narration about the class at:
<https://www.youtube.com/watch?v=M5Jk-1YdiOg>. ■

STUDENT RESEARCH

STRIVING TO STRENGTHEN STRUCTURES

AN INTERDISCIPLINARY
TEAM CONDUCTS TESTS
TO IMPROVE RETROFIT
METHODS FOR SEISMICALLY
VULNERABLE CONCRETE
BUILDINGS





IN A CAMPUS LAB nearly hidden from public view, a handful of interdisciplinary students are working on a research project to improve retrofit methods for seismically vulnerable concrete buildings.

The research, led by architectural engineering Assistant Professors Anahid Behrouzi and Michael Deigert along with Professor Peter Laursen, is funded by the Research, Scholarly and Creative Activities (RSCA) Grant Program administered by the California State University's Chancellor's Office and Cal Poly's Office of the Provost.

Since September 2018, a diverse group of graduate and undergraduate students have been working on improving the performance of non-ductile concrete walls.

The project originated when alumnus Garrett Hagen (ARCE, '11; M.S., ARCE, '12), an engineer in Degenkolb's Los Angeles office, approached Laursen while investigating innovative retrofit approaches for wall systems in the state's older buildings. Experimental evidence was lacking; Hagen was hoping Cal Poly could help fill that void.

California has more than 2,000 vulnerable pre-1980s non-ductile reinforced concrete public buildings, according to a 2011 Concrete Coalition report. A Los Angeles County ordinance requires retrofitting or demolishing noncompliant structures within the next decade, requiring the expertise of many structural engineering firms.

"Older concrete walls have little to no confinement in the highly stressed compression zones at wall ends, which can result in sudden catastrophic failure during an earthquake," Behrouzi said. "Conventional solutions include thickening existing walls or adding walls in a floorplan, both costly and time-consuming

LEFT: Graduate students Rory de Sevilla (on the ladder) and Jerry Luong prepare equipment in the High-bay Lab for wall testing.

ABOVE: During the test, the students will observe the performance of a non-ductile concrete wall specimen constructed by the team.



LEFT: Rory de Sevilla inspects an optical laser displacement sensor before installing it.



BELOW: Jerry Luong hand pumps the actuator that will apply lateral load to the wall.

approaches. A few firms are pursuing more rapid and cost-efficient fiber reinforced polymer (FRP) retrofit strategies.”

But strategies for improving wall ductility have not been fully examined or tested. Until now.

“We are investigating the effectiveness of confining the ends of non-ductile slender reinforced concrete walls with FRP sheets and splay fiber anchors. The aim is to use a noninvasive and cost-effective approach to increase wall displacement capacity without significantly affecting lateral strength,” Behrouzi said.

ARCE graduate students Jerry Luong and Rory de Sevilla, alumnus Luke Ostrom (ARCE and Construction Management, ’18), alumnus Carlos Espitia (Construction Management, ’19), CM undergraduate Jonathan Ott, and mechanical engineering undergraduate Ian McCandless are doing the work in the High-bay Lab.

“We had to make improvements to the lab before we could begin,” Behrouzi said. That included the addition of a Simpson Strong-Tie Strong Frame, one of several donations from industry partners in support of the research.

Other donors include CalPortland (concrete), Ryan Stolz Concrete & Pumping (concrete pumping services), Fyfe-Aegion (FRP and associated student training), and Dywidag-Systems International (prestressing bars for load application system), among others. (*See sidebar, opposite page.*)

Alumnus Ostrom was tenacious in obtaining the donations. “He called the companies, explained our project, and obtained the materials,” Behrouzi said.

Laursen added, “Our department enjoys the support of the industry. Despite our rather modest research budget, we were able to upgrade our testing facility.”

Students constructed the first of three experimental walls. Built to half-scale, the wall is 5 inches thick, 60 inches long, and nearly 12 feet high.

“The specimen design is informed by pre-1970s concrete building code provisions and existing vintage walls. The students ran the design calculations as well as figured out wall strength and displacement capacities. This has been a prime example of Learn by Doing,” Behrouzi said.

Most of the design work was done by de Sevilla and Luong, who were seeking a senior project that was “technical, hands-on and could tie into sustainability and resiliency.” Both de Sevilla and Luong continued the work as a graduate thesis project.

Luong acknowledged that it took an enormous amount of effort. “Everything takes three times longer than expected,” he said.

They helped produce drawings, made predictions about the performance of the wall, upgraded the lab, and fabricated the wall. Luong said seeing the wall come to fruition was a

DONATIONS OF TIME, FUNDING AND MATERIALS MAKE THIS RESEARCH POSSIBLE

Several factors have to come together in order for a project of this size to get off the ground:

- ✓ Shop technician Vince Pauschek has dedicated countless hours, and his expertise has been crucial to the project.
- ✓ Additional funding was provided by the Architectural Engineering Department Parents Learn by Doing Fund.
- ✓ Rory de Sevilla was awarded a Structural Engineers Foundation Research Grant.
- ✓ Alumnus Garrett Hagen, a Degenkolb structural engineer, is serving as an engineering advisor.
- ✓ Fyfe-Aegion is supplying engineering assistance through a team that includes Scott Arnold, Reymundo Ortiz, Cristian Molina and Victor Reyes.
- ✓ These companies generously donated materials:
 - Simpson Strong-Tie
 - CalPortland
 - Dywidag-Systems International
 - Fyfe-Aegion
 - LMS Reinforcing
 - McClone Consulting
 - Ryan Stolz Concrete & Pumping
 - Zircon

just reward for their hard work. “Every milestone we reach is gratifying and motivates us for the next challenge. I’ve learned there are at least five takeaways from every failure,” Luong said.

Professor Laursen, a former bridge engineer, knows that involving students in such a large-scale research project pays dividends. “It requires them to initially think about the big picture,” he said. “What are the individual tasks required to get to the goal? How do we actually construct a concrete wall? How do we make the formwork and temporary supports? How is reinforcing arranged and the concrete cast? How do we test and measure the behavior of the wall?”

Students typically don’t get to experiment on a project of this magnitude and scale. “We conducted the most comprehensive structural testing project in the ARCE Department in decades,” Laursen said.

Behrouzi added, “We included a great deal of instrumentation to examine how the retrofit impacts wall response. Even if it doesn’t perform as anticipated, we are still able to inform the industry.”

After tests are completed on the first wall, they will tear it down and build another. “This project could extend into something for multiple students over a long period of time,” Behrouzi said. “And it could change the way people retrofit.” ■



TOP: Professor Peter Laursen and students note results during the wall test.

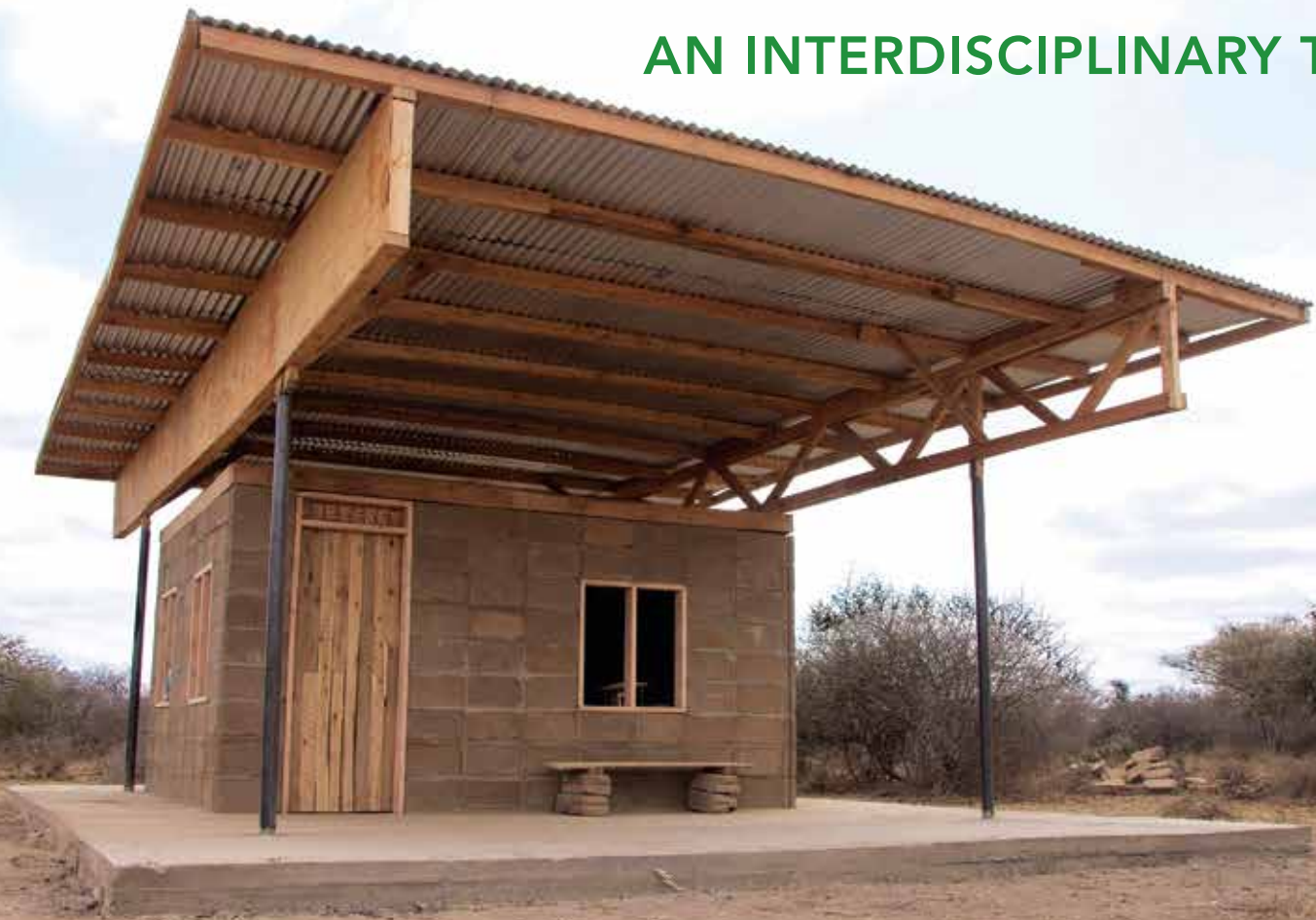
ABOVE: The team’s notations detail few, wide crack planes not consistent with modern walls containing boundary elements.

EXPERIENCES ABROAD



TANZANIA

AN INTERDISCIPLINARY TEAM





PRODUCES PROTOTYPES FOR A COLLEGE PROJECT

FOR THE PAST three years, an interdisciplinary team of Cal Poly faculty, alumni and students in architectural engineering (ARCE) and architecture have partnered with the Mbesese Initiative for Sustainable Design to develop designs for a proposed technical college in Same (Sah-may), Tanzania. The college would provide educational opportunities that increase human capital and reduce the region's severe poverty levels.

The students create models for campus growth, establish overarching planning principles, and define design goals for buildings and infrastructure to support 1,200 students.

"In each instance, the students completed an analysis, then created drawings or documents that were used for construction," explained ARCE Professor Kevin Dong. "Proposals addressed material availability, cost, fabrication, installation and maintenance."

In summer 2018, 11 students, four alumni volunteers, and Dong and architecture Professor Tom Fowler traveled to Tanzania and constructed a micro-structure based on a building prototype design that incorporated block wall testing, wind tunnel/natural

ABOVE: A team of faculty, alumni and students constructs a micro-structure with local builders and community volunteers.

OPPOSITE PAGE: Team members show off the finished structure, which incorporates block wall testing, wind tunnel/natural ventilation studies and a thermal comfort/CFD study.

ventilation studies, and a thermal comfort/CFD (contract for difference) study. They worked with local builders and community volunteers to construct the 180-square-foot space.

"The trip gave students a better understanding of the cultural, environmental and physical considerations that accompany designing and building in developing areas," Dong said.

One student remarked, "I traveled to Tanzania with vague expectations to learn about culture and construction; however, I left with much more: a tremendous appreciation for people I never knew, lifestyles I didn't know existed, labor I hadn't realized was necessary, and a country that has impacted my career and life path."

This year, a group returned to design and construct a pedestrian bridge. "Volunteers are always welcome to join Tanzania Build," Dong said. ■



Inch by

IN EARLY SEPTEMBER 2018, Cal Poly SESH (Structural Engineering Students for Humanity) embarked on a life-changing mission to Kathmandu, Nepal, to work on humanitarian projects with Miyamoto Global Disaster Relief.

Architectural engineering (ARCE) Professor Peter Laursen and fourth-year students Jenna Williams and Elyssa Adams led a team of 13 students on the two-week journey.

SESH was created seven years ago by structural engineering students to aid developing countries in performing seismic retrofit work and to give students a chance to see the positive impact their studies can make.

Last year, the students raised \$10,000 to support two projects: the Shree Janavikash Higher Secondary School and the Gaddi Baithak (or Royal Seat) UNESCO World Heritage site, both damaged in the 2015 earthquake. Longtime ARCE Department supporter Ashraf Habibullah, president and CEO of Computers and Structures Inc., funded 13 students' lodging and travel, and Smith Structural Group funded the trip for two of its student employees.

It was the students' first trip to Nepal.

"Stepping out of the Kathmandu airport was surreal," Williams recalled. "It wasn't until that moment that I fully grasped the task we had committed to. We didn't read or speak Nepali, and yet here I was, leading a group of 13 students.

"After the initial shock, I knew I had to be fearless," Williams continued. "My peers were looking to me for guidance. This trip gave me the most challenging and rewarding way to discover the things I am capable of achieving."

In typical Cal Poly style, the students hit the ground running. In just one week, they developed sets of as-built drawings, performed a detailed damage assessment, mapped damages, and recommended retrofit solutions for both projects.

"We also created 3D models of the buildings so the engineers who continue the project will have a complete picture of the project to reference," Williams said. "The students were also able to engage with the local community, which is perhaps the most important part of any humanitarian trip."



TOP: ARCE senior and trip co-leader Jenna Williams said the visit to Nepal changed her perspective on life.

LEFT: ARCE students (from left) Tommy Sidebottom (yellow vest), Colin Ridgley and Mark Wright work on project details with local students on the steps of Shree Janavikash Higher Secondary School.

Inch

STUDENTS HELP WITH SEISMIC REHABILITATION ON A RETURN TRIP TO **NEPAL**



Advisor Laursen agreed. “They were great at involving people,” he said. “Jenna and Elyssa did incredible jobs, making sure everybody was well prepared, leading every day trip in Kathmandu, and getting everyone back home safely.”

Williams recalls her first impression of the country as “simultaneous chaos and calm.”

She said, “There were cars and motorcycles and bikes going every which way. Cows roamed the streets and monkeys climbed the telephone poles. Yet everyone knew where they were going and where everyone else was going. It reminded me of an army of ants or bees in a hive ... lots of noise and movement, but almost no collision. Everything was harmonious.”

The Nepali people made a lasting impression on Williams. “No matter what their status, rich or poor, the people were extremely grateful for what they had,” she said. “It gave me a new perspective on where I should place my values and what defines my happiness.”

After the long work week, the students and Laursen spent several days trekking in the foothills of Kathmandu and taking a river rafting trip.

“This wasn’t just a ‘feel good’ effort,” Laursen said. “We left something behind. We started something, and we delivered a good product.” ■



TOP: ARCE senior Michael Goldenberg collects data on site.

ABOVE: The Cal Poly team’s work included developing as-built drawings, mapping damages, and recommending retrofit solutions.



WITH JUST TWO WEEKS to go before leaving on a yearlong sabbatical to help with post-recovery efforts in the earthquake-ravaged city of Christchurch, New Zealand, architectural engineering (ARCE) Professor James Mwangi saw the ad that would change everything: The nonprofit Build Change and product manufacturer Simpson Strong-Tie were looking to fill

the inaugural Simpson Strong-Tie Engineering Excellence Fellow position.

Mwangi's original plans were to work with Miyamoto International. He had an apartment waiting for him in Christchurch, his medical exams were completed, his bags were practically packed. Still, he was compelled to apply for the fellowship.

"I am passionate about the kind of work that Build Change does, and I've worked with both organizations previously," Mwangi said.



ARCE PROFESSOR
JAMES MWANGI
SPENDS A YEARLONG
FELLOWSHIP IMPROVING
CONSTRUCTION IN
DEVELOPING NATIONS

Build Change designs disaster-resistant houses and schools and helps homeowners, builders, engineers and government officials develop and implement building standards in emerging nations.

“Emerging countries in hazard-prone areas are some of the most at-risk for natural disasters because of the increased vulnerability of their infrastructure,” said Lizzie Collins, director of engineering at Build Change. “Many houses are built informally, without engineering input, and many schools are

ABOVE: Architectural engineering Professor James Mwangi is the center of attention at a public school in Indonesia — one destination of many in his work in a fellowship program established by Simpson Strong-Tie and Build Change. The program endeavors to help developing countries build safer schools and homes.



ABOVE: Professor Mwangi's work in Indonesia included spearheading a project to produce better bricks.

▼

"I worked on life safety — how to retrofit homes to make them safer, so that if an earthquake hits, the residents would have time to get out safely."

built without adequate disaster-resistant design and construction."

Simpson Strong-Tie is a leading producer of structural products that help people build safer, stronger structures. Build Change and Simpson Strong-Tie joined forces to establish the fellowship to help developing countries build safer structures and to give innovative engineers the opportunity to make "impactful contributions" to housing and schools in those locations.

Mwangi seemed a natural choice to fill the fellowship position.

"We selected Dr. Mwangi as the first fellow because of his practical hands-on skills and his extensive knowledge and expertise in masonry, timber and seismic design," Collins said. "He also has a wealth of experience in applying his structural engineering expertise from California to other locations, particularly in developing countries.

"Of course, we also greatly value Professor Mwangi's expertise and experience in teaching, his great communication abilities, and his very approachable and positive attitude," Collins continued.

Mwangi was honored to be selected as the first fellow. "But it was tough calling Miyamoto to tell them I wasn't going to New Zealand," he confided. "My stomach was in knots when I broke the news, but they understood — and I was relieved."

Mwangi is now back at Cal Poly after a whirlwind year of months-long stays in Indonesia, Colombia and the Philippines, where he worked on projects to strengthen and improve poorly constructed schools and homes.

From July 1, 2017, to June 30, 2018, Mwangi worked on four projects in three countries. "Before leaving the States, I worked remotely on a project for Haiti," he explained. He reviewed and advised on content for engineering training materials for the Haiti Ministry of Education Engineers.

Then he headed to the "Ring of Fire" countries, those at greatest risk of being struck by strong earthquakes. Mwangi spent August and September in Indonesia, October through February in Colombia, and March through June in the Philippines — countries where building codes are not typically enforced for housing and where he could make a real difference.

In Indonesia, he worked to improve the safety of public schools and reviewed design and construction guidelines. "I prepared reports on how to revise, harmonize and consolidate design and construction requirements from the Ministry of Education and Culture, Ministry of Public Works, and National Agency for Disaster Management," Mwangi said. He also helped with retrofit design and a project to make better bricks.

In Colombia, he met with several professors, accompanied technical teams on field trips, and developed retrofit cards for certain one-story buildings.

In the Philippines, Mwangi reviewed retrofit design guidelines, visited

construction sites, and conducted a seminar on earthquake-resilient building design and construction.

"In Colombia and the Philippines, the construction is poor," Mwangi explained. "These cities are highly populated and the construction — much on hillsides — is dangerous. I worked on life safety — how to retrofit homes to make them safer, so that if an earthquake hits, the residents would have time to get out safely."

In all these countries, Mwangi was a teacher and a mentor, working with local engineers who had never had a building code enforced.

"I was very busy, but it was so rewarding," Mwangi said. "There was no down time — it was boom, boom, boom! There was no template; I designed the program as I went along. I had great support from Build Change's Director of Engineering Lizzie Collins."

The only hitch Mwangi encountered was with the various languages. "In Haiti, all the documents are in French. I don't speak much French," Mwangi said. "In Indonesia, the documents are in Bahasa Indonesia — the toughest language I've ever heard!

"I thought all would be well in Colombia because I speak some Spanish," he continued. "But they speak Latin American Spanish, which is very different. I spent a lot of time using Google Translate. Luckily, equations look the same in any language."

Mwangi was especially pleased to see the tasks that he had laid out in each of these countries come to fruition.

"In every country I went to, we completed every task we set out to do," he said. "Everything was going to be implemented. In the Philippines, Columbia and Indonesia, the locals

▼
**"I was very busy, but
it was so rewarding.
There was no
down time — it was
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I designed the program
as I went along."**

BELOW: On a visit to assess an elementary school's seismic vulnerability, Mwangi is joined by Build Change Indonesia Country representative Ani (center) and the school's headmistress.



▼
“If you’re patient,
don’t bring any drama,
and respect other
people’s cultures, you
will be welcomed
wholeheartedly.”

RIGHT: The professor works with the
Medellin home inspection group
in Colombia.

BELOW: A construction site in Bogota,
Colombia, warrants an inspection.



had tried to team up with university professors to test materials, but they had hit a wall. My credentials as a professor helped open doors and facilitate meetings that otherwise had been put on hold. Suddenly doors opened, which opened up communication.”

He wasn’t just the teacher in these countries; he also learned some important lessons. “If you’re patient, don’t bring any drama, and respect other people’s cultures, you will be welcomed wholeheartedly.”

Collins said Mwangi more than met the challenge. “He was the ideal inaugural candidate — an excellent combination of teaching and mentoring expertise, professional seismic engineering experience and practical hands-on know-how of construction practices,” she said.

Other Build Change staff members praised him as well. “His presence on the team was positive since day one, and the team really bonded with him,” said one. “He shares positive energy, has a very collaborative attitude, and he is always prone to teach and to involve everyone in the discussion.”

Mwangi was credited for providing strong support to teams and to the mission.

“In Indonesia, he supported our engineers in several aspects of our Safer Schools program — from designing a school retrofit to doing a technical review of the current government standards for school construction and rehabilitation,” Collins said. “In Colombia, he supported our team in reviewing our existing resources for evaluating and retrofitting vulnerable housing in order to find ways to try to improve and simplify the resources. In the Philippines, he supported our engineering team in improving technical resources for evaluating and retrofitting vulnerable houses as well as finding ways to simplify and standardize current practices and methods to tackle different building types, like reinforced concrete frames with infill.”

Mwangi said the whole experience was amazing. “I cannot believe this



actually happened to me. I have to pinch myself and ask, ‘What were the chances that two companies that I had worked with in the past would select me as their first fellow?’ I cannot believe it happened.”

Mwangi, who remains in frequent contact with Build Change, will no doubt return to those countries. “I absolutely will return. These problems didn’t end when I left,” Mwangi said. “I continue to be involved with them almost on a daily basis.”

Department Head Al Estes added, “As global experiences are becoming increasingly important, James’ accomplishments are that much more valuable. Most importantly, James has become a mentor, role model, facilitator and faculty advisor for those ARCE students who want to do the same thing.”

Mwangi will accompany ARCE students to Myanmar this summer.

Editor’s note: For a more detailed list of Mwangi’s fellowship activities, go online to www.buildchange.org/blog. ■

ABOVE: Professor Mwangi works with local contractors on a school construction project in the Philippines.

▼
“I absolutely will return [to those countries]. These problems didn’t end when I left.”



STUDENTS GAIN RESEARCH EXPERIENCE IN A **NEW ZEALAND FELLOWSHIP PROGRAM** AND INSIGHT FROM LOCAL ENGINEERS ABOUT QUAKE-DAMAGED AREAS

ABOUT A DOZEN Cal Poly architectural engineering (ARCE) students since 2014 have bolstered their studies in New Zealand as part of the Cal Poly-University of Auckland Research Fellowship, a program founded by alumnus Lucas Hogan (ARCE, '09).

After earning his bachelor's degree from Cal Poly, Hogan went on to earn his doctorate from the University of Auckland (UoA), where he serves as a research fellow in the Civil and Environmental Engineering Department and lecturer and director of the university's Structures Testing Lab. He also oversees the summer research fellowship program.

The program, developed specifically for Cal Poly, allows a few students every summer to explore the world of research, gaining insight into how structures actually perform, according to Hogan. It's a win-win for all concerned.

"The program gives us an opportunity at UoA to recruit high-quality students for our graduate programs leading to a master's or a doctorate," Hogan said. "As well, the students get exposure to a research

ABOVE: Shannon Abeling (right) — meeting with Professor Anahid Behrouzi (left) in 2018 — was the fellowship program's first participant.

RIGHT: Christchurch structural engineer Marga Lamoreaux (ARCE, '07) takes the Cal Poly visitors on a tour of areas damaged by 2015's Canterbury earthquake.



ROADENING THEIR RESPECTIVE



EXPERIENCES ABROAD

environment that allows them to decide if graduate study with a research degree is for them. And it helps demystify some of what they are taught, in particular about how provisions in the building code were developed.”

In 2014, Shannon Abeling (ARCE, ’15) became the program’s first participant and the first to enroll in the UoA’s doctoral program. The summer fellowship exposed her for the first time to engineering research. Her keen interest in historic building retrofits led her to

enroll in the four-year doctoral program, which she expects to finish by the end of the year.

“I was impressed with UoA’s research in the lab and in the field,” Abeling said. “Enrolling in the Ph.D. program seemed the best way to be exposed to the most up-to-date technology and research.” Her doctoral thesis relates to identifying the risk associated with unreinforced masonry buildings and developing methods to prioritize retrofit interventions.

In New Zealand, she’s analyzed damage photographs and casualty data from the 2010-11 Canterbury earthquakes. “Based on the data, I’m developing a model to predict where debris from masonry buildings will fall in future earthquakes and the likelihood that a

person will be hurt from falling debris,” Abeling said. She also completed an initial seismic assessment of churches in the region and developed a method to prioritize seismic intervention based on the assessments.

It’s been hard work, but it has paid off. “I’ve grown into a more confident and competent engineer,” she said. “I’m happy I pursued my Ph.D. It’s given me opportunities that I would otherwise never have had. I’ve conducted research that I find interesting, and I taught myself skills that will help me down the line. I’ve presented my research at conferences in New Zealand, Australia and Europe.”

New Zealand, which has been hit by several large earthquakes in the past several years, is funding a significant amount of relevant research, resulting in tremendous

BELOW: ARCE alumnus Tommy Sidebottom (left) joins Lucas Hogan — ARCE alumnus and founder of the Cal Poly-University of Auckland (UoA) Research Fellowship program — in a UoA lab to conduct a wall test.



opportunities for professors and students. Cal Poly ARCE student researchers have helped UoA professors test pile foundations, unreinforced masonry walls and concrete beams, as well as quantify the damage and casualty rate of retrofitted buildings versus those not retrofitted.

Last year, with support from a UoA research fellowship, ARCE Assistant Professor Anahid Behrouzi also conducted research in Auckland for five weeks. During this time, she arranged a visit to the University of Canterbury for Cal Poly alumnus Tommy Sidebottom (ARCE, '18) and ARCE students Ryan Schwartz, and Rory de Sevilla.

"Drs. Behrouzi and Hogan planned this trip, which included meetings with local engineers, site visits, and a brief snapshot of a recovering community," de Sevilla said. "Christchurch was devastated by an earthquake a few years ago, so it was especially humbling to see the destruction firsthand and to talk to the locals about how life has changed."

De Sevilla, who is pursuing a master's degree at Cal Poly, spent over two months at UoA working with a professor specializing in timber connections, specifically the resilient slip friction joint (RSFJ).

"The RSFJ is a developing proprietary seismic joint spearheaded by Professor Pierre Quenneville and his company, Tectonus," de Sevilla said. "The RSFJ is composed of sandwiched alligator-like steel plates clenched together by incredibly robust cylindrical springs."

It is designed to protect structures from earthquakes by dissipating energy through friction, allowing structures to rock and re-center so that the building comes back to its original state.

De Sevilla said that, similar to Cal Poly, the work at UoA is very hands-on. "Many days, I was in the testing lab tasked with drilling holes for test setups, checking the quality of ordered parts, painting steel and tightening bolts. Most of these tasks were not foreign to me, thanks to Cal Poly's strong Learn by Doing philosophy," he said.



The main difference, de Sevilla said, was the ability to work in UoA's state-of-the-art research lab.

"The experience was fulfilling academically and otherwise," he said. "It was a unique balance of internship experience and cultural immersion. Because of the very loose structure of the internship, I learned how to be responsible for my own learning. I also

TOP: (from left) ARCE alumnus Tommy Sidebottom and ARCE students Rory de Sevilla and Ryan Schwartz participated in the research fellowship program in 2018.

ABOVE: The Cal Poly group tours one of Christchurch's earthquake-damaged Arts Centre buildings with Peter Carney, senior project engineer at Holmes Consulting, the firm in charge of the renovation project.

EXPERIENCES ABROAD

got some behind-the-scenes experience with how doctoral-level research can evolve into building codes.”

During Schwartz’s summer fellowship, he helped develop best practice guidelines for digital image correlation (DIC) — basically how to determine deformations in structures using two cameras. The technique has the ability to measure down to 30 microns (0.03 mm) or 1.2 thousandths of an inch.

“Instead of using normal instrumentation to record strain and displacement data, the DIC system utilizes images taken during an experiment to compute the data,” Schwartz explained. “To do this, a proper pattern must be applied to the specimen that the cameras can track,

BELOW: Tommy Sidebottom (left) and Anahid Behrouzi (center) get a tour of the University of Canterbury’s Structural Engineering Lab.

RESEARCH FELLOWSHIP PROGRAM PARTICIPANTS

Since its inception, the following students have spent summers participating in the Cal Poly-University of Auckland Research Fellowship program.

2014: Shannon Abeling

2015: Peter Inman
Julio Mendoza

2016: Kiersten Bakke
Katie Eberle
Ryan Lefebvre

2017: Anugrah Gupta
Tia De Harpport
Sophie Moore

2018: Rory de Sevilla
Ryan Schwartz
Tommy Sidebottom

2019: Alejandra Bravo
Nick Slavin

and a proper test setup is made to be sure the data are precise and accurate.

“It’s harder than it sounds,” Schwartz continued. “If mistakes are made with the test setup — for example, if the lighting changes throughout the experiment or if too much vibration occurs while photographing the specimen — the data could be inaccurate. The guidelines I developed will allow researchers to easily apply the system to any experiment and avoid the pitfalls that could occur with haphazard use.”

Schwartz said the independent work he did in Auckland was more research oriented and exploratory than what he was used to at Cal Poly. “I was tasked with a problem, and through my knowledge, experience and initiative, had to come up with a solution.”

Sidebottom investigated the reparability of reinforced concrete beams.

“Because concrete buildings will suffer damage during a design-level earthquake, it is important to understand the ability to repair these specimens,” Hogan said. “Tommy investigated this with full-scale testing of a repaired beam.”

Much of the work being done by Hogan, his colleagues, and the students involves developing building code standards. “If students get to be directly involved with the research, they will start to think critically when they are using codes in design,” Hogan said. “It turns the perception of those documents from laws about buildings brought down on stone tablets to one of a collection of well thought-out and researched work.”

Department Head Al Estes added, “This has been a terrific program for the department. Lucas is to be congratulated for suggesting the program and then spearheading the effort year after year. Students get both a valuable research experience and global adventure in one summer package.”

ARCE students Nick Slavin and Alejandra Bravo will participate in the program this summer. ■



Good News for Masons



PROFESSORS BALTIMORE, MWANGI RECEIVE PATENT FOR SUSTAINABLE, SELF-CONSOLIDATING GROUT

STRUCTURAL ENGINEERS MAY soon have another choice when it comes to selecting grout for structural masonry walls: a sustainable self-consolidating grout, developed by Cal Poly architectural engineering (ARCE) Professors Craig Baltimore and James Mwangi, together with Kurt Siggard of the Concrete Masonry Association of California and Nevada (CMACN).

Self-consolidating grout (SCG) is highly fluid and offers advantages over standard grout. For instance, it flows easily and fills voids without vibration, and as a result, it saves time and labor.

However, the SCG commonly used today is made with chemicals; the sustainable SCG created by Baltimore, Mwangi and Siggard is not. Their product — which took nearly seven years to perfect — has received a U.S. patent.

“Chemical-based self-consolidating grouts are sensitive — not robust — thus quality and ease of use can vary, which can limit their usefulness,” Baltimore said. “By eliminating the chemical additives, the quality and ease of use are expected to increase while giving consistent reliable results.

“Our sustainable grout repurposes industrial waste materials fly ash and blast furnace slag,” Baltimore continued. “Builders can save labor and time on the construction site, with minimal comparative additional hard costs. The soft-cost savings in time and labor are far greater than the initial material costs.”

Baltimore anticipates wide industry use in “high seismic areas where fully grouted walls are required,” but he cautioned that it has only been proved in the laboratory. “In-situ verification is our next step,” he said.

Department Head Al Estes added, “The entire department is proud of Craig and James for their success in conducting this consolidated grout research, publishing their findings in multiple venues, and successfully attaining a patent on this process. We are also very grateful to Kurt Siggard and the CMACN for their support of this work and the ARCE program in general through scholarships, academic materials and course sponsorships.”

The CMACN recently renewed its \$50,000 sponsorship of the ARCE 305 Masonry Design course. ■



TOP: A student conducts a standard grout test of the American Society for Testing and Materials known as “slump flow.”

ABOVE: A diagram touting the benefits of the product.

On Course

JILL NELSON RECEIVES LPA GRANT TO FUND INTEGRATED DESIGN STUDIO

"I WOULD DEFINITELY recommend that architectural engineering (ARCE) students take ARCE 415: An Integrated Design Studio for the structurally engaging ideas it presents and as an introduction to what it is like to work with other disciplines."

That's just one critique from a student who completed the latest iteration of this interdisciplinary class in fall 2018. Funded by a \$20,000 grant from LPA Inc., an integrated design firm with offices in California and Texas, the course goal was to create a constantly changing environment in which students would apply their skills in concert with architecture and landscape

architecture students, according to ARCE Associate Professor Jill Nelson.

"ARCE 415 has been our premier upper-division interdisciplinary course for the last eight years," Department Head Al Estes said. "While lauded by industry, it has been one of our most difficult courses to conduct for a variety of reasons. I am grateful to firms like LPA for providing financial support to this endeavor and involving the firm's resources in the project."

Designed for fourth-year ARCE, architecture and landscape architecture students, the class was developed and team taught by Nelson, architecture Assistant Professor Jennifer Shields, and landscape architecture Assistant Professor Ellen Burke.

Integrated design requires the collaboration of all allied disciplines, right from

the start of a project. Architectural engineers know how to calculate the capacity of a braced frame and how to size a beam for deflection; what they don't know is how it integrates into a successful project.

"Integrated design allows the delivery of high-quality and sustainable environments," Nelson said. "A well-coordinated integrated design can reduce costs, timeframes, and the need for redesign. Collaboration leads to innovation."

About 50 students enrolled in the inaugural LPA-sponsored studio, deemed a success by the students who took it and the faculty who taught it. LPA will sponsor the experience with a different project and instructor team in fall 2019, and the course will be offered again in winter 2020. ■

BELOW: Students present their projects for critique in ARCE 415: An Integrated Design Studio, an interdisciplinary course.





Honors Abound

ARCE FACULTY PRESENT PAPERS AND EARN RECOGNITION AT NATIONAL CONFERENCE

THREE ARCHITECTURAL ENGINEERING (ARCE) faculty members presented papers and were honored for their teaching, scholarship and distinguished service during the 2019 American Society of Engineering Education (ASEE) conference in Tampa, Florida, in June.

Department Head Al Estes and Assistant Professors Anahid Behrouzi and Michael Deigert were recognized at the Civil Engineering Division Banquet that is held as part of the three-day conference.

Behrouzi and Deigert shared the Gerald R. Seeley Award, which recognizes a civil engineering faculty member with five or fewer years of teaching experience for the quality of his or her paper submitted for presentation in a Civil Engineering Division session at the ASEE annual conference. The award includes a certificate and \$500 to help offset the cost of conference registration fees.

Behrouzi also won ASCE's Project ExCEED (Excellence in Civil Engineering Education) Teaching Award, established by the ASCE Committee on Faculty Development to recognize and reward outstanding new faculty.

Estes was awarded an engraved plaque in recognition of his winning this year's George K. Wadlin Award for sustained and distinguished service to the Civil Engineering Division of ASEE, support of its activities, and notable contributions to civil engineering education.

During the conference, Deigert presented his and Behrouzi's award-winner paper, "Exposing Undergraduates to Design, Fabrication and Large-Scale Experimentation in a Structural Steel Design Course." The paper was co-authored by ARCE students Jenna Williams and Mark Wright.

Also at the conference, Behrouzi presented two papers. The first, "Interactive Physical Experiments in an Advanced Undergraduate Structural Dynamics Course," was co-authored by Cal Poly alumnus Chad Facciolo (ARCE, '18). It was presented as part of a session on physical models where each author had five minutes to describe and demonstrate their hands-on teaching aid.

Behrouzi's second paper, "E-Learning Tools to Facilitate Instruction of a Large Enrollment Structural Engineering Course,"



TOP, LEFT: Department Head Al Estes (center) is presented with the George K. Wadlin Award by Tom Lenox, ASCE executive vice president emeritus, and Andrea Welker, ASCE CE division chair.

TOP, RIGHT: Assistant Professor Anahid Behrouz (left) receives the ASCE's Project ExCEED Teaching Award from Camilla Saviz, chair of the ASCE Committee on Education.

ABOVE: Professor Michael Deigert displays his Gerald R. Seeley Award.

is a result of her summer 2018 trip to the University of Auckland in New Zealand.

Estes presented "Diversity, Inclusion and the ExCEED Teaching Workshop," which was based on his 20 years of participating in this workshop. ■



Professor John Lawson

Kudos!

JOHN LAWSON IS PROMOTED TO FULL PROFESSOR

ARCHITECTURAL ENGINEERING
Department faculty member and alumnus John Lawson (ARCE, '83) has earned the rank of full professor, effective in the 2019-20 academic year.

Lawson started teaching at Cal Poly 10 years ago, after a 25-year career in structural engineering. He remains an industry consultant, sharing lessons he learns with his students.

"I believe my passion for the subject matter is evident in my enthusiasm in class," Lawson said. "My stories from industry often dovetail well with the class material and keep the students engaged. One of my mentors, ARCE Professor Ed Saliklis, told me that the cost of today's college attendance equates to a ticket to the Metropolitan Opera per lecture, and I

use that as a motivator to see that the students get their money's worth!"

In addition to teaching, Lawson is active in the Structural Engineers Association of California, American Concrete Institute, National Council of Structural Engineers Association, and American Society of Civil Engineers.

His research involves looking for new developments in the design and analysis of single-story tilt-up and masonry buildings with flexible diaphragms.

Lawson said the most rewarding aspect of teaching is "when my students find fantastic careers of their own and call to say they still use notes from my class! It's like being a proud parent every graduation." ■



Professor Ed Saliklis

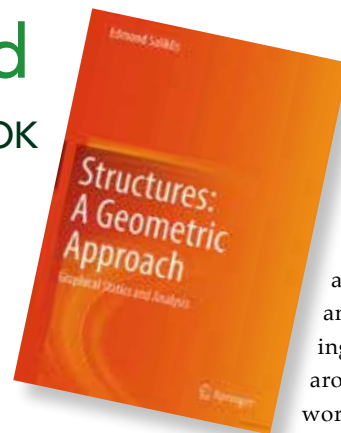
Newly Published

ED SALIKLIS PENS TEXTBOOK ON GRAPHICAL STATICS

ED SALIKLIS' APPRECIATION of graphic statics, a nearly forgotten method for linking structural form to forces, led him to write a textbook, "Structures: A Geometric Approach — Graphical Statics and Analysis," recently published by Springer International.

"Graphic statics was developed in the middle of the 19th century," said Saliklis, longtime Cal Poly professor of architectural engineering (ARCE). "It flourished until the early 20th century, then suddenly disappeared. It's a wonderful tool that combines analysis and design, giving students a 'feel' for how forces flow through a structure."

The book is intended as a textbook for students worldwide. "Neither metric nor imperial units were used, thus the book could be used in any country," Saliklis explained. "It can also be used by practitioners who understand statics but have never used graphic statics.



"If every architecture and engineering program around the world stopped teaching algebraic

statics today and switched to a geometric approach, we would see enormous benefits immediately," the author continued. "Everyone loves solving geometric puzzles and drawing these beautiful shapes. In an arm-wrestling contest between graphic statics and algebraic statics, graphic statics easily wins every time."

The textbook was so well received that Saliklis has signed a second contract with Springer International to write another book, this one tentatively titled "Structures: A Studio Approach." ■



Upon the Boardwalk

Architectural Engineering Department faculty and staff members are (front row, from left): Mario Esola, Anahid Behrouzi, Adriana Sousa (former staff), James Mwangi, Erika Clements (staff), Jill Nelson, Department Head Al Estes, John Lawson, Pamalee Brady and Dahlia Hafez. Back row (from left): Kevin Dong, Michael Salmon (staff), Brent Nuttall, Mike Deigert, Craig Baltimore, Graham Archer, Peter Laursen, Ed Saliklis, Cole McDaniel and Rob Down.

Meet Jamie Budd

ARCE WELCOMES NEW ASSISTANT

CAL POLY ALUMNUS Jamie Budd (Environmental Earth Science, '18) stepped in to fill the void in the Architectural Engineering (ARCE) Department when former Administrative Assistant Adriana Sousa left in October 2018 to begin a career as a copywriter for a local marketing company.

Budd started working for the department as a temp. "I so thoroughly enjoyed the atmosphere and the faculty and staff that I applied for the permanent position," Budd said.

Her days are busy creating department and class schedules; coordinating events; helping students with registration and advising; coordinating student scholarships; and responding to inquiries from the general public, prospective students and their supporters.

"My favorite part of the job is getting to know the students and helping them work through this exciting and challenging time in their lives," she said.

Before her undergraduate days, Budd worked in retail management, mostly as a store manager for Levi Strauss and Co.

She, her partner, Jeremy O'Kane, and their 4-year-old son are avid hikers and campers and have visited 10 national parks and 11 state parks in under four years.



Jamie Budd enjoys hiking and camping at state and national parks.

"We thank Adriana for her service to this department and wish her the best," Department Head Al Estes said. "I could not be happier to have Jamie on board. She is very smart, helpful and conscientious. She has quickly become invaluable, and we are very lucky to have her." ■



ON^{THE} BEAM

ALUMNUS MICHAEL PAROLINI MAKES THE TRIBUNE'S
'TOP 20 UNDER 40' LIST FOR HIS PROFESSIONAL
ACHIEVEMENTS AND VOLUNTEER WORK



ALUMNUS MICHAEL PAROLINI (ARCE, '03) had never heard of Cal Poly before he applied for admission in 1997.

"My architectural drafting teacher at Oakdale High School suggested I apply to Cal Poly's architectural engineering (ARCE) program because of my aptitude for architectural graphics, construction and math."

Parolini had never been to campus — or to San Luis Obispo — until the summer of 1998. Twenty-some years later, he — with his wife, Kelsey Anne Parolini (nee Deering), also a structural engineer and 2003 Cal Poly ARCE graduate — still resides on the Central Coast, where he is managing partner and principal structural engineer at SSG Structural Engineers LLP. He cofounded the company in 2011 with two other Cal Poly alumni: Michael Smith (ARCE, '79) and Lee Engelmeier (Civil Engineering, '95).

In addition to student-focused financial support, Parolini gives back to Cal Poly by serving as a member of the ARCE Industry Advisory Council. He also taught part time in the College of Architecture and Environmental Design from 2005 to 2017.

With all he's accomplished, it's a fitting tribute that he was named to San Luis Obispo Tribune's 2018 "Top 20 Under 40" list honoring the county's "best and brightest leaders" under the age of 40.

Perhaps it started with his days at Cal Poly, at a time when computers were not yet used to teach engineering. "It was still practical application-based," he said. "We learned how to think and problem solve. We weren't scared to be wrong. It was true Learn by Doing."

The former Mustang brings a unique perspective to the ARCE Industry Advisory Council.

"I serve at the pleasure of ARCE Department Head Al Estes," Parolini said. "To Al's credit, I was invited to join after a disagreement we had about a topic in the department magazine. He said, 'That sort of voice is exactly what I need on my advisory board ... someone who thinks and sees things differently from me and will let me know.'"

"That's a true leader," Parolini continued. "The board gives industry members a voice in the program. Our industry is changing — not the basics of physics or engineering, but the application of that knowledge and its intertwining with industries such as public policy, finance and insurance. If current students are prepared like students in the past, they won't be ready for what's waiting for them in their pending careers."

SSG Structural Engineers employs 26 at its San Luis Obispo and Fresno locations. When hiring, Parolini often looks to Cal Poly.

"Our firm is predominately Cal Poly graduates, although we have a couple of Bulldogs and one Beaver," Parolini said. "While diversity of thought from multiple university backgrounds is great, we know who we are, we know what we do, and Cal Poly students are generally a known quantity when it comes to knowledge and drive."

Parolini suggests that to get ahead, students should consider earning an MBA or a master's in public administration.

"If you want to affect real change in our industry, learn how to be a better partner to the people sitting across the table from you," he advises. ■



ABOVE: Michael Parolini observes progress at the Epoch Estate Wines tasting room, an NCSEA Excellence in Structural Engineering Award-winning project involving adaptive reuse of an 1880s unreinforced masonry building.

OPPOSITE, TOP: Parolini receives San Luis Obispo Tribune's "Top 20 Under 40" honors in 2018.

OPPOSITE, BOTTOM: Parolini (foreground) takes Cal Poly students on a tour of the Bishop Street Studios project.



Reunited

ANNUAL BAY AREA GATHERING ATTRACTS ROBUST CROWD

MORE THAN 60 people gathered to reunite with old classmates, forge new friendships, and catch up on current events at the Cal Poly Architectural Engineering (ARCE) Department's eighth annual ARCE alumni reception, held March 8. The popular event, which attracted alumni of all ages, has become a traditional alumni get-together on the night prior to the annual Computers and Structures Inc. (CSI) party (see back cover). This year the alumni event was held at Schroeder's Restaurant in downtown San Francisco. ■

RIGHT: Christine Theodoropoulos, dean of Cal Poly's College of Architecture and Environmental Design, chats with ARCE alumnus Daniel Bastiao ('04).



TOP: The Schroeder's reunion attracted (from left) Tim Frei ('92), with his wife, Amy Frei, and Reece Relatores ('10).

ABOVE: Department Head Al Estes (right) catches up with ARCE alumni (from left) Tyler Pizarro ('17), Onessa Anastasio ('17) and Jack Tenley ('18).



ARCE's 2018-19 Advisors

THE ARCHITECTURAL ENGINEERING (ARCE) Department appreciates the industry partners who generously volunteer their time and expertise to serve on the ARCE advisory board. The 2018-19 board members recently met with faculty and students in the High Bay Lab to observe the retrofit research project underway. (See article, Page 14.)

Front row (from left): Donna Clandening (AC Martin); ARCE Department Head Al Estes; former faculty member Abe Lynn (Degenkolb); and ARCE graduate students Jerry Luong and Rory de Sevilla, members of the research project team.

Standing (from left): Bryan Seamer (LPA); Michael Parolini (SSG Structural Engineers); Elisa Suarez (SpaceX); Jennifer Hiatt (TriCal Construction); Chris Haight (Coffman Engineers); Shawna Peterson (Sares Regis Group); Matt Melcher (Lionakis); Steve Pelham (Barrish Pelham); faculty member Michael Deigert; Ron LaPlante (Division of State Architect); Liz Mahlow (Nous Engineering); Randy Collins (FTF Engineering); Margaux Burkholder (Englekirk); Steve Patton (ZFA Structural); and Professor Peter Laursen. ■

BUILDING REWARDING CAREERS

ARCHITECTURAL ENGINEERING ALUMNI
THRIVE ON **BUEHLER ENGINEERING'S**
COLLABORATIVE CULTURE, HIGH-END WORK

NEARLY ONE-THIRD — or 18 — of the 62 engineers employed at Buehler Engineering Inc. are Cal Poly architectural engineering (ARCE) alumni. Bill Rader (ARCE, '84), senior principal, was the first on board, right after graduation.

"Cal Poly ARCE grads are the best prepared and most collaborative engineers we hire," Rader said. "They understand the design process and possess the skills we value most. They can get right to work; they know how to put a set of documents together and how to approach the problem-solving aspect of what we do."

Rader has filled many roles during his time at Buehler. Currently he has a leadership role and is involved in high-level project management, overseeing roughly 20 projects at any given time. He believes Cal Poly's focus on architectural



and structural design provided a solid foundation for his success.

"They taught us how to put a drawing and calculation package together and how to collaborate with other design professionals," Rader said. "That's precisely what Buehler does."

Buehler Engineering Inc., founded in 1946, has four California locations and one in Phoenix.

According to Krista Looza (ARCE, '04), associate principal and Los Angeles regional office manager, "Buehler fosters a work-hard culture of commitment to our projects, clients and each other. It's also a culture in which everyone gets along and enjoys doing things together. We're a family; we help each other succeed."

Looza too joined Buehler right after graduation, and the job was just what she had expected. "I came into the job doing exactly what we did in school, only faster and more complete," she said. "The last few years, though, have been a journey discovering what more I am capable of and what other skills I possess. Buehler gives me the freedom and support to do that."

Looza indeed balances many tasks — hiring staff and managing projects, engineers and office needs.

"We recently relocated to downtown L.A., so I searched with a broker for new space," she said. "I evaluated spaces, negotiated the lease, and managed the office design and construction."

As project manager, she oversees myriad projects — from the Los Angeles International Airport's Automated People Mover to school buildings. In her business development role, she spends time with clients, shares project leads, and writes fee proposals.

She admits that juggling it all is a challenge. "The rhythm and demands of



ABOVE: The Los Angeles International Airport Midfield Satellite Concourse is part of a multi-billion dollar expansion at LAX.

RIGHT: Among the 18 ARCE alumni working at Buehler are (from left): Jason Horwedel ('02), Krista Looza, Jeret Buerger and Scott Hooker ('98).

projects have a pace that doesn't always sync well with business development activities or office management. But it keeps me on my toes," she said.

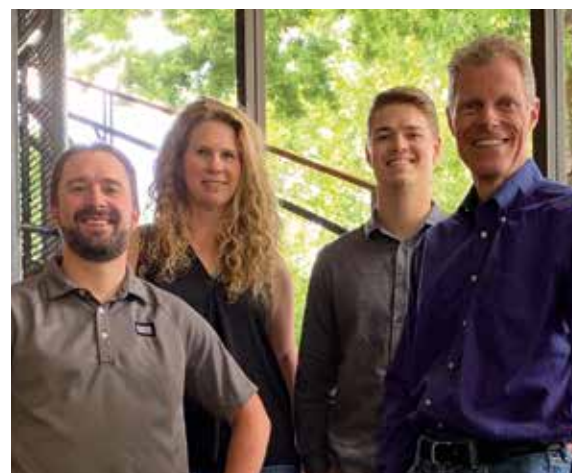
Charis (Wu) Leong (B.S., ARCE, '14; M.S., ARCH, '14) joined Buehler as an associate four years ago and finds everyone willing to help. "I can ask any colleague for help," Leong said. "Because everyone has different backgrounds, they have different solutions to the same problem."

She tackles a variety of tasks with enthusiasm. "Every day is different," she said. "Some days I'm building finite element models, drawing details and doing calculations. I also spend time out of the office at meetings and site visits."

Leong worked on the new San Francisco Airport's Long-Term Parking Garage No. 2, a 1.2-million-square-foot concrete moment frame structure.

"Because of the structure's size, it was divided into four seismically independent quadrants," Leong explained. "One challenge was detailing the rebar at the beam-column joints. There are a lot of bars in a limited area, so we created large-scale details with all of the bars drawn to scale to ensure that everything would physically fit as we designed it."

Jeret Buerger (ARCE, '18), the youngest Cal Poly alumnus on Buehler's staff, is an engineer in training.



"Buehler provides young engineers with a wealth of knowledge," he said. "There are so many talented structural engineers here. If I need help, I can approach anyone for advice; no one is too busy to help."

Just as Buerger was beginning his career, Buehler was starting construction on the New Natural Resources Headquarters, a \$500 million, 22-story steel building that will house such California state agencies as the California Natural Resources Agency and the Department of Parks and Recreation.

"I was able to jump into the construction administration process by reviewing shop drawings and going on structural observation visits to the site," he recalled. "I never thought I would be part of such a big project so early in my career." ■

OPPOSITE, TOP: The Rideout Regional Medical Center expansion in Marysville, California, added a new six-story, acute care hospital tower with a rooftop helistop.

OPPOSITE, LEFT: The Golden 1 Center in downtown Sacramento, California, spans four city blocks.

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1 Grand Avenue
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CAL POLY REVELERS ROCK TO **CSI PARTY'S** BOLLYWOOD THEME

Cal Poly architectural engineering (ARCE) students, faculty, staff and alumni attended the Computers and Structures Inc. (CSI) 44th anniversary party in record numbers on March 9 at City Hall in San Francisco. The theme for this year's party was Bollywood.

"The ARCE population seems to grow each year as CEO Ashraf Habibullah continues to provide such great support to this program, and the students who have recently graduated keep returning," said Department Head Al Estes. "We collectively thank Ashraf for his generosity and for continuing to invite us to the party of the year. We took more than our fair share of space on the dance floor."

TOP: CSI founder and CEO Ashraf Habibullah lights up a room.

ABOVE: Dancers (from left) are CSI guest and ARCE alumni Brooke Lipsey, Meghan Navarro, Alex Remiticado, Adam Pruitt, Michael Blanchard and Maja Sagaser.