INTERSECTIONS

CALIFORNIA POLYTECHNIC STATE UNIVERSITY, SAN LUIS OBISPO

COLLEGE OF SCIENCE AND MATHEMATICS

FALL 2022

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CALIFORNIA POLYTECHNIC STATE UNIVERSITY, SAN LUIS OBISPO
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COVER

Photo by Izzy Kelly, graphic communication and photography student.
All participants of 2022 Frost Summer Undergraduate Research Program, biologicial sciences Professor Jean Davidson (second from right) with biological sciences students (from left) Evan Odberg, Bell Aduaka and Chanel De Smet transport equipment into the soon-to-be-completed William and Linda Frost Center for Research and Innovation. See Page 8 to learn more about the new facility.

LEARN BY DOING

* Asterisked names denote current Cal Poly student contributors.

Marine science students Ellie Engle and Jake Roth led a group of seniors from Lindsay High School to explore Cayucos tide pools and learn how to do scientific surveys of clams. Engle holds an ochre sea star (*Pisaster ochraceus*), a species whose populations have been impacted by the sea star wasting disease in recent years.

As part of Cal Poly's partnership with the Santa Rosa Creek Foundation, the College of Science and Mathematics and the Center for Coastal Marine Sciences aim to attract future marine scientists from historically underrepresented groups, supporting them through the beginning of their undergraduate or graduate school career.

Photo by Joe P. Johnston

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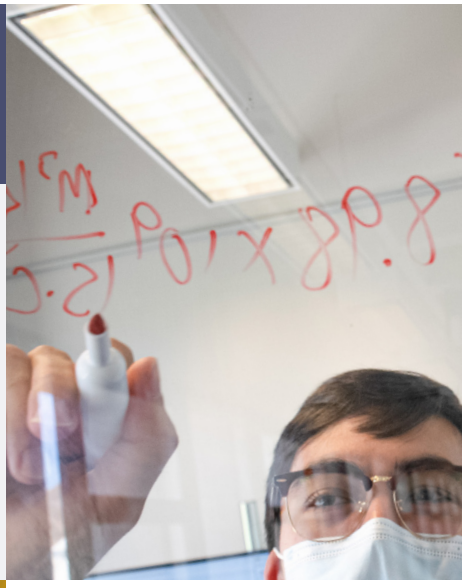

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Stepping into the Future of Learn by Doing

> *"We must continue to collaborate and solve meaningful problems together as we change our communities and the world for the better."*

In looking back at the past few years, I'd like to take a moment to appreciate the significant progress made in our work and lives. We've come together as a college community and are now poised to step into an exciting future for Learn by Doing. We've enjoyed gathering again in person for class, events, workshops, projects, extracurricular activities and more.

I'm thankful for the dedication and ongoing commitment of our faculty and staff to student success, and to their tireless work in providing our students with rich learning opportunities in science, mathematics and education even during a time that presented unforeseen and stressful circumstances.

As grateful as I am to our faculty and staff, I am also humbled by the support from alumni who give back generously in so many ways to help students and faculty thrive and pursue their passions.

I'm delighted that after years of planning, we'll see undergraduate research expand and flourish with the launch of the William and Linda Frost Center for Research and Innovation — providing new research space that will benefit future generations of students and faculty for decades to come.

We're truly grateful for and honored by the generosity of the Frosts and so many others who have contributed to help establish the College of Science and Mathematics as a premier institution for undergraduate research with learning resources that are unmatched within the state and across the nation. With this incredible investment in our college, we will continue to excel and vigorously pursue knowledge and seek innovation while being mindful of how we use our expertise to impact the greater good.

In this noble pursuit, we produce graduates that are highly desirable candidates who make their mark and find reward in a wide range of careers in industry, academia, nonprofits, government and education.

As we move into this promising and bright new future, we must continue to collaborate and solve meaningful problems together as we change our communities and the world for the better.

Sincerely,

Dean Wendt,
Dean

CAL POLY
College of Science & Mathematics

2022 Student Research Conference

MICRO VIEW of the temporary science tattoos that many attendees applied on themselves at the 20th annual Student Research Conference hosted by the College of Science and Mathematics in the Baker Center, May 12-13, 2022. The conference included poster presentations, student talks on innovative and relevant research projects, and — for the first time — alumni mentor sessions.

MACRO VIEW of conference attendees viewing and discussing research posters. Students presented their undergraduate research through more than 80 poster displays and approximately 40 talks covering a wide range of topics. Dean Wendt (far bottom right) said, "This research is exemplary of the hands-on, Learn by Doing approach, and it contributes to new understanding helping solve real-world problems."

cosam.calpoly.edu/conference

Revealing the Future of Undergraduate Research

THE WILLIAM & LINDA FROST CENTER FOR RESEARCH & INNOVATION

After more than four years of planning and construction, a new four-story building at Cal Poly that will dramatically enhance research and student learning opportunities for generations opens this academic year.

In May 2019, construction crews broke ground on the new William and Linda Frost Center for Research and Innovation.

The 102,000-square-foot building is located across from the Baker Center for Science and Mathematics along North Poly View Drive.

The new facility, in its final phases of construction, features efficient design with spacious windows, views of Bishop Peak, gas and water hookups from lab ceilings, a rooftop garden, and three dedicated research centers.

The $125 million Frost Center was made possible by alumnus Bill Frost (Biochemistry, ’72) and his wife, Linda. Additional lead funding was provided by Jim and Suzanne Boswell (Boswell Agricultural Technology Center), Jack and Felicia Cashin (Expressive Technology Studios), the California State University (CSU), Cal Poly Corporation, and dozens of other donors.

The Frosts’ $110 million gift was announced in 2017, representing the largest gift ever in CSU history.

The Frost gift includes $34.5 million for the new building, research equipment and enhancements such as the rooftop garden and atrium wood.

“This modern and well-equipped new building gives us significantly more laboratory space for research with cutting edge, state-of-the art equipment,” said Dean Wendt, dean of the College of Science and Mathematics (CSM). “This is transformational in that the physical plant better enables undergraduate students and their faculty mentors the ability to collaborate in solving important problems facing our society.”

About 71% of the building’s space is assignable, meaning available for programmatic purposes, including modern labs, computational tools, instruments and wet labs.

THIS PAGE: (From left) President Jeffrey D. Armstrong, Bill Frost, Linda Frost and Phil Bailey toured the construction site of the William and Linda Frost Center for Research and Innovation in May 2022. They are standing at the south entrance in front of a four-story wall faced with bricks spelling out "Discere Faciendo" — Learn by Doing in Latin. OPPOSITE PAGE: One of 13 new lab spaces built for the college in the Frost Center. ***Photos by Izzy Kelly.***

Three large classrooms offer seating for about 180 students, 100 students and 60 students for use across campus disciplines.

"Bill planned his gift with us very carefully, recognizing this center as a significant part of his life's work that's extremely meaningful to him as well as to our students, faculty and staff," said Phil Bailey, director of the Frost Fund and CSM dean emeritus who met Bill Frost in 1970 when Bill was a student. "We are extremely grateful for his vision, philanthropy and contribution to undergraduate research and student opportunities."

The Frost donation also covers costs associated with scholarships and stipends for students, equipment and instrumentation, hiring of more instructors and giving faculty members more time to mentor undergraduate students in research.

"Bill really liked doing research when he was here at Cal Poly, and even spent some nights in buildings here on campus, because he was so committed to his chemistry projects," Bailey recalled. "He valued the role of education and his relationships with faculty while a student and continued to do so even after graduating and developing his own companies."

Frost funding also established the new Plant Conservatory located on the hill overlooking Poly Canyon Village at the intersection of Village Drive and Poly Canyon Road. The conservatory had to be moved to make way for the new building.

The conservatory features multiple controlled environments to grow plants from around the world, outdoor meeting and research areas, and office spaces for technical staff and students.

The new Frost Center greatly expands resources for research among faculty who currently share facilities, some packed into tight quarters, and the proximity of the new lab spaces facilitates multidisciplinary collaboration.

"There's going to be greater chance for cross-pollination," said Chris Kitts, director of Cal Poly's Center for Applications in Biotechnology. "Instead of walking across campus, I can go down the hall and have a conversation about a program or project. I'm looking forward to the possibilities of unexpected connections that form from working in the same areas."

Physics Professor Ryan Walter said his new work area will help build, program, and troubleshoot instruments and electronics used for oceanographic research.

"I'll use the space to stage field experiments," Walter said. "I will also conduct lab experiments looking at rotating, stratified fluids, simulating what happens in the ocean."

As a biological sciences student at Cal Poly in the 1990s, Wendt conducted in-person research off campus in marine science at Diablo Canyon Nuclear Power Plant.

"I had amazing teachers and mentors in the faculty at Cal Poly, but many of them didn't have active research programs and labs 30 years ago," Wendt said. "The student that wanted that research experience often had to find a way to piece it together back then."

Expanded opportunities for research on campus "is the major impact of this new building," Wendt said.

"This is bringing more physical resources to student research opportunities and the teacher-scholar model," Wendt continued. "Bill and Linda Frost have enriched the learning opportunities for our students, and they have enabled us to maintain our competitive edge in being a premier institution that will attract the best students, staff and faculty."

FROST CENTER FACTS

102 K gross square feet — 72,400 of which is assignable or usable space.

30 K gross square feet — assignable space for the College of Science and Mathematics.

13 new laboratories — built for the College of Science and Mathematics.

32 chemical fume hoods — installed for the College of Science and Mathematics.

$125 M cost of project — funded by private, industry and state sources.

3 colleges
- College of Science and Mathematics
- College of Agricultural, Food and Environmental Sciences
- College of Liberal Arts

8 CSM research areas supported — **Chemistry** (synthetic and analytical); **Biochemistry**; **Physics** (soft matter and particle detection); **Center for Coastal Marine Sciences**; **Center for Applications in Biotechnology**; **Center for Health Research**; **Cell Therapy Manufacturing Lab**; **Computational Molecular Sciences Lab**

Algae Research and Capturing CO2

STUDENT WORKS WITH ALUMNI-FOUNDED COMPANY ON DEVICE TO CAPTURE CARBON FROM THE ATMOSPHERE

By Nick Wilson

Haley Edwards has learned through research as a Cal Poly biological sciences undergraduate to keep asking questions when she encounters stumbling blocks.

Even if she doesn't find the solution through her process right away, the information gathered helps to form a better understanding of the science.

Edwards is a Frost student researcher collaborating with biological sciences Professor Elena Keeling and a Cal Poly alumni startup company called Extraction Design LLC to study how captured carbon might enhance algae growth.

"In class, you generally have clear direction and answers, whereas research is a lot more challenging because you have to figure out what you don't know," Edwards said. "And then you have to figure out what you should be asking when things aren't working out as you expect, which is not a skill that I had before this. But I'm definitely working on it."

Extraction Design, made up of five Cal Poly alumni who graduated between 2017 and 2019, created a device using a resin material that effectively absorbs and stores carbon dioxide.

Among the company's visions for product application is to effectively reduce emissions into the atmosphere and help cultivate algae, feedstock and liquid fertilizers, all of which are aided by various forms of dissolved carbon.

"Our hope is to see the climate mitigation efforts realized and to provide a path to start actively reducing CO2 in our atmosphere," said Extraction founder and CEO Megan Skilling (Architecture, '17). "The need for carbon capture technology is more evident now than ever. We are excited about the opportunity to make a real difference in the world."

The Cal Poly research is studying potential ways of aiding the growth of algae, which thrives in aquatic environments in a liquid solution by infusing trapped carbon from the Extraction Design device.

If implemented on a large scale, which would take further research and development, a carbon-infused algae enhancement could help reduce greenhouse gases in the atmosphere and have commercial benefits.

"The problem of what to do about all the carbon in the air is so big that it's important for different people to be trying to solve that problem in different ways," Keeling said.

Globally, scientists also are exploring how algae might be broken up for use as biofuels and as an alternative to fossil fuels.

Edwards, a biological sciences major from Irvine, California, previously conducted some field biology studies at Cal Poly and analyzed samples. She grew to enjoy lab work and sought out Keeling who connected her with the algae project.

The fifth floor Baker Center lab space is shared with other Cal Poly researchers studying electrical properties and biofuel applications of algae under physics Professor Jon Fernsler and electrical engineering Professor Dean Arakaki.

Edwards' workspace reveals a collection of Erlenmeyer flasks and vials of solution growing clumps of algae. Flasks jiggle back and forth on a vibrating shaker to stimulate growth.

Edwards has been able to hone her problem-solving skills, which will help in her planned future career as an obstetrician.

Her current challenge is to try to figure out how best to limit the amount of carbon that escapes when transferring it from its stored space to use as fertilizer for algae.

The carbon captured by the Extraction Design resin material is released into liquid solutions contained in flasks used for algae fertilizer. But off-gassing is a challenge as carbon exchanges between air and liquid form within the contained flasks.

"Storage is a huge problem because gas wants to be gas (and thus escape the liquid solution)," Edwards said. "It certainly has been a learning curve to work through the logistics of this project."

One potential fix is to add buffers, such as phosphate ions, which prevent the solution from becoming more acidic as the carbon dissolves. Keeping it more basic — versus acidic — helps the carbon stay in solution.

"I'm playing with different chemical buffers that hopefully will prevent the carbon from off-gassing as quickly," Edwards said. "I need to figure out how to get my buffer to hold without killing or stunting the algae growth."

Edwards said the project will require additional time and coordination, but the learning experience has helped her thus far.

"I think what will be applicable for me is the communication and collaboration aspect of it," Edwards said. "I've really gotten to learn to talk to people of all different backgrounds about the project or about different applications or related projects. And I think those communication skills are going to be very, very useful."

Skilling, said the Keeling Lab "is the perfect place to help us test the feasibility of this application."

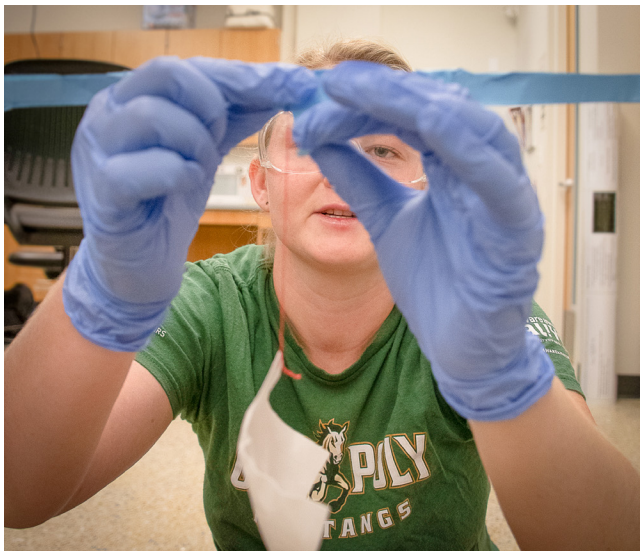
The Extraction Design team, led by Chief Science Officer Christian Vian (Chemistry, '19), recently applied for National Science Foundation funding to continue research and development of the carbon capture device with the hope of commercializing it.

Other multidisciplinary team members include Kristen Fauske (Architecture, '17), Nico Kent (Wine and Viticulture, '19) and Saul Flores (Architecture, '17), who served as consultants.

"Once we have successfully brought this technology to market and scaled it successfully, we will look to solve future environmental challenges and increase public awareness on environmental issues and our proposed solutions," Skilling said.

OPPOSITE: Edwards examines an algae culture sample in the Keeling Lab as part of her research. ABOVE: Flasks containing algae samples. BELOW: Edwards hangs a piece of resin to test how much CO2 it captures from the air.

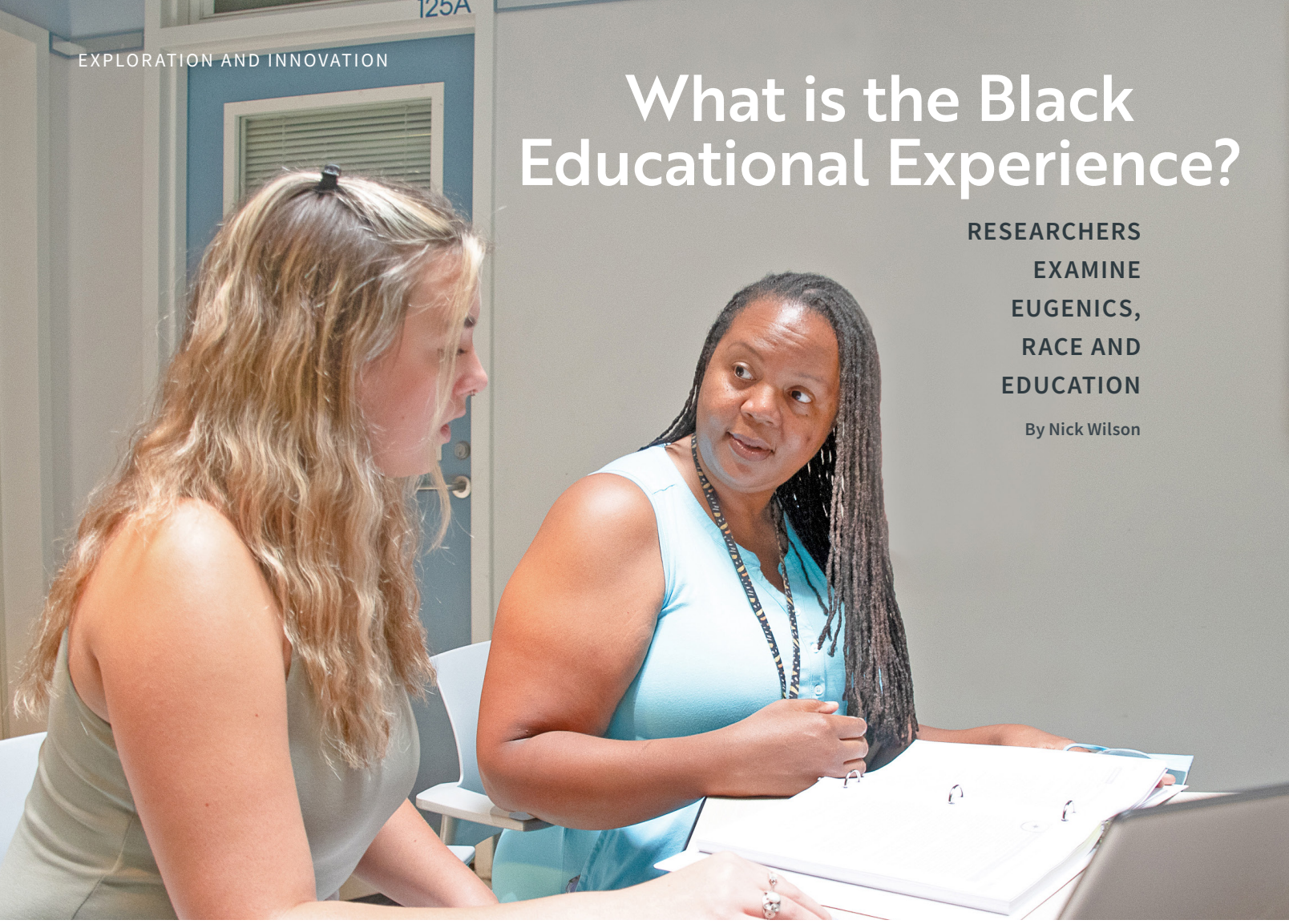
Photos by Izzy Kelly.



What is the Black Educational Experience?

RESEARCHERS EXAMINE EUGENICS, RACE AND EDUCATION

By Nick Wilson



Perceptions about race and intelligence can be formed early on in a child's life, and Cal Poly liberal studies Professor Amanda Frye wants to better understand the question: "Who gets to decide who gets to be smart?"

Frye is exploring how lingering effects of eugenics relate to teaching education and how it impacts students.

Eugenics, or race science, is the theory or belief system in a racialized, social hierarchy and notions of superiority and inferiority, which played a significant role in late 19th century and mid-20th century education that aligned with school segregation and stereotypes about intelligence.

Frye and her team of two undergraduate student researchers are reviewing textbooks commonly assigned to liberal studies and credential program students in the California State University system, the largest producer of K-12 teachers in the country.

The team is examining ways in which terms such as "urban," "poverty" and "class," — which often imply race — can shape teachers' impressions about communities, schools and academic potential.

"Emergent patterns in the textbooks speak to the confirmation or challenge of teachers' beliefs about academic potential across these different domains of identity," Frye said. "What teachers believe about a student's potential influences their actions."

They're also examining how references to English as a second language, immigration status and disability are presented.

"What I've seen so far in the textbook reviews is the use of the word 'urban' to represent people of color and people from lower income neighborhoods, and it's usually used in a very negative way, as if students are not as able and it's harder to teach there," said Kaya Johnston, a liberal studies major and one of two undergraduate student researchers on Frye's team.

Conversely, "gifted" and "talented" can be associated with wealthy and white students, Johnston said.

This Frost-funded research formally began in summer 2022 with a goal of helping teachers better realize the responsibility and conduct of shaping human development.

Frye recalled an unsettling conversation at a fundraiser when she worked previously in the nonprofit sector. She was talking with a man about a teen center that had many students of color.

"Our kids were going on to do amazing things," Frye said. "I made the comment that a student was interested in astrophysics and biomedical engineering, and this guy literally laughed when I

talked about imagining the future these kids could have. He said, 'I don't know about all that.'"

Frye perceived him to be supportive of the organization's mission, but it was clear that his vision for the students' potential was limited.

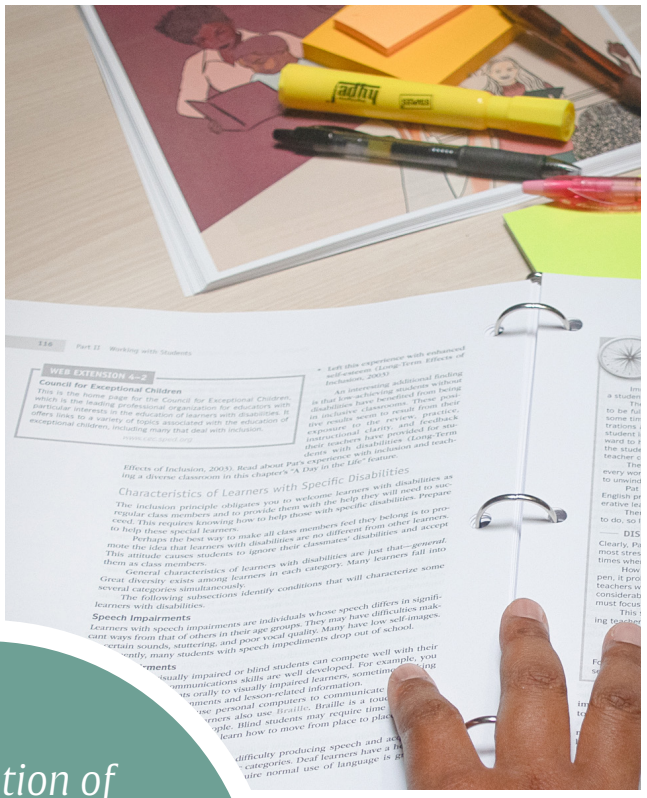
"I wondered, 'What's stopping you from seeing our kids as potential innovators and academic and intellectual leaders?'" Frye said. "The question of 'Who gets to decide who gets to be smart?' really brought me out of nonprofit work and back into academia."

Perceptions of academic potential have carried over from the 1950s and 1960s, when biology textbooks widely used in the United States carried ideas about race and intelligence being inherited, Frye said.

Growing up in the 1970s and 1980s, Frye recalls teachers being "continually surprised by me and kids like me demonstrating our excellence and intelligence."

Frye went on to study at Harvard University, where she earned a B.S. degree in Russian and Soviet studies in 1991 and master's degrees in human development and psychology in 1994 and in urban education/sociology of education in 2012.

She earned her doctorate from Stanford University in sociology of education and race, inequality and language education in 2018.



> *"The question of 'Who gets to decide who gets to be smart?' really brought me out of nonprofit work and back into academia."*

Frye said that pedagogical studies distinguish between a "fixed mindset" of intelligence (the idea that a student just isn't good at math, for example) versus a "growth mindset" that assesses learning challenges not as critiques of character but as an "opportunity to feel your brain growing."

The difference can mean a student "studying really hard for a test because they know my teacher thinks I can make it over this bar, or I'm not going to bother with it because I'm clearly just going to get a D all over again," she said.

Frye is not aware of any journal papers that take on her research topic, thus opening the door to contributions of new insights and to advance change.

Johnston is a first-generation college student who's minoring in ethnic studies.

"This project really stood out to me because I took one of Dr. Frye's classes before and she's just amazing," Johnston said. "I hope schools will notice this and steer their syllabi away from using these texts and maybe even pull different articles from different authors and not necessarily push this. These texts are obviously problematic and reinforcing stereotypes."

OPPOSITE: (From left) Liberal studies student Kaya Johnston and liberal studies Professor Amanda Frye during a research meeting. LEFT: Amanda Frye. ABOVE: Educational materials examined by the research team.

Photos by Izzy Kelly.

From Deep Sky to Deep Respect

ASTRONOMY PROFESSOR EARNS AWARDS AND RECOGNITION

By Nick Wilson

A Cal Poly physics professor is spearheading an astronomy-related, data analysis research project that will contribute to new discoveries and understandings of stars and galaxies never seen before.

Professor Louise Edwards is leading a research team of undergraduate students at Cal Poly and three other California State University campuses (Stanislaus, San Diego and Pomona).

Edwards is the principal investigator of a four-year study that has received more than $1 million in research grants (about $1.12 million) from the National Science Foundation (NSF).

The study, awarded in June, directly partners with the Vera C. Rubin Observatory Project to investigate deep space regions of the universe. The massive Rubin survey telescope project is under construction in Chile with plans to begin operations in 2024.

A digital camera system designed by SLAC, the Department of Energy's National Accelerator Laboratory located on the Stanford University campus, will attach to the new 8.4-meter telescope to view space objects more than 10 billion light years away from Earth.

While other types of telescopes can pinpoint objects farther out, Vera C. Rubin will document the deepest survey of the night sky ever recorded in expanse and field of range.

"This will be the ultimate Google Zoom of the universe," Edwards said. "You'd have to build a wormhole and [or] travel at the speed of light to physically get to these outer reaches of the universe."

The light-sensitive, charge-coupled device (CCD) imager that converts photons to electrons will capture the outer space images that will lead to new discoveries regarding the evolution and formation of galaxies, Edwards said.

Already, scientists associated with the project, including Edwards' team, are building big data and computing cataloging systems that will help document the findings from the telescope as future images are captured.

"What scientists have been working on for the last couple years is a huge simulation of the universe, a computer-built universe," Edwards said. "We get to explore that simulated universe using the tools we'll need in two years when real data comes online. Along the way, we're building testable predictions of the evolution of stars and galaxies using a dataset simulated to match the data coming off the new telescope."

The impact of the study eventually will provide tools to best answer some fundamental questions, such as "What is the structure of the universe?" and "What does the map of the universe look like?" along

with new information about light distribution and dark energy and dark matter (matter that doesn't absorb or reflect light and is thought to make up a large majority of the universe).

The technology will bring in fresh views of the largest galaxies likely ever to be recorded, including ones 10 times the size of the Milky Way.

The project will collect data on more galaxies in its first year of operation than in the history of astronomy, with opportunities for the public to interact with and explore the observatory's data.

"That will allow us to do the largest, deepest survey of the sky that humans have ever done," Edwards said. "What this project is about is getting all together to work as a community of scholars to learn how to deal with this data. It's a huge survey with terabytes and terabytes of data (totaling more than 500 million gigabytes) and not something you can simply put into your own computer."

Edwards and her student team members are collaborating to create computer codes using Python, a high-level programming language, in Jupiter Notebook that best simulates what they expect to view in the form of galaxy mass, numbers of stars and differentiations between blue stars (containing hotter compositions) and red stars (cooler compositions).

"We're learning some astronomy together," Edwards said. "We're learning what's available in the data that will be catalogued when the real data comes along. Because when it comes back to us, it's going to have literally millions of galaxies."

Edwards' research team, which met weekly and collaborated extensively over the summer, is comprised of five Cal Poly undergraduates: Kevin Zhang, Luisa Gonzalez, VicentePuga, Melina Ruano and Denvir Higgins.

"I advertised for the research positions and received about 30 responses from students from various majors and backgrounds, including mechanical engineering, physics and students in the Cal Poly Astronomical Society," Edwards said. "At the end of the day, I thought it would be really great to combine a couple of physics majors, who have a physics way of thinking about astronomy, with a couple of engineers, who have really awesome computing skills."

> *"That will allow us to do the largest, deepest survey of the sky that humans have ever done."*

Research assistant Ruano, a Cal Poly aerospace engineering student and president of the Cal Poly Astronomical Society, said that she grew up in East Los Angeles, in Montebello, where she rarely saw stars.

"I do remember always seeing the moon, and I'd always be curious," Ruano said. "It wasn't until middle school and high school that I started getting the gist for astronomy and how crazy it is that there are these objects so far away. So that's how my astronomy passion started. Once I came to Cal Poly, my interests just grew."

Another project participant, Cal Poly physics major Vicente Puga of Culver City, said he joined because he wanted research experience.

Puga said that he has faced hurdles to navigate the challenges of writing astronomy-related computer code, seeking Edwards' guidance when he gets stuck.

"I just struggled through some of this code," Puga said. "I like trying to learn it. But Professor Edwards is also always there because she encourages us to ask her questions."

At Cal Poly, Zhang's interest has continued to grow through classes and a part-time job at Cal Poly's Observatory, as well as his photography of the night sky, a side hobby.

"I took a class with Dr. Edwards about stars and galaxies," Zhang said. "And in that class, I was just really awestruck and captivated by the way that she describes how galaxies merge with each other. Once she told me that she was doing research, I had to jump in.

"Doing research, we get to take all that knowledge from class and then put it into practice and study a very specific part of why galaxies merge," Zhang concluded.

Learn more about undergraduate research in the College of Science and Mathematics at ***cosam.calpoly.edu/undergraduate-research.***

OPPOSITE: Louise Edwards in front of the photo mural of Mars surface displayed in the Baker Center for Science and Mathematics. ABOVE: Edwards with research students (from left) Luisa Gonzalez, Melina Ruano and Vicente Puga.
Photos by Joe P. Johnston.

THE SEARCH FOR BIODEGRADABLE GLUE!

Research Team's Quest for the Perfect Diels-Alder Poised to Result in Patent

By Nick Wilson

A Cal Poly faculty member and several students have developed, in collaboration with an East Coast company, a new adhesive that has the potential to significantly impact the amount of consumer materials that are recycled in the U.S. and worldwide.

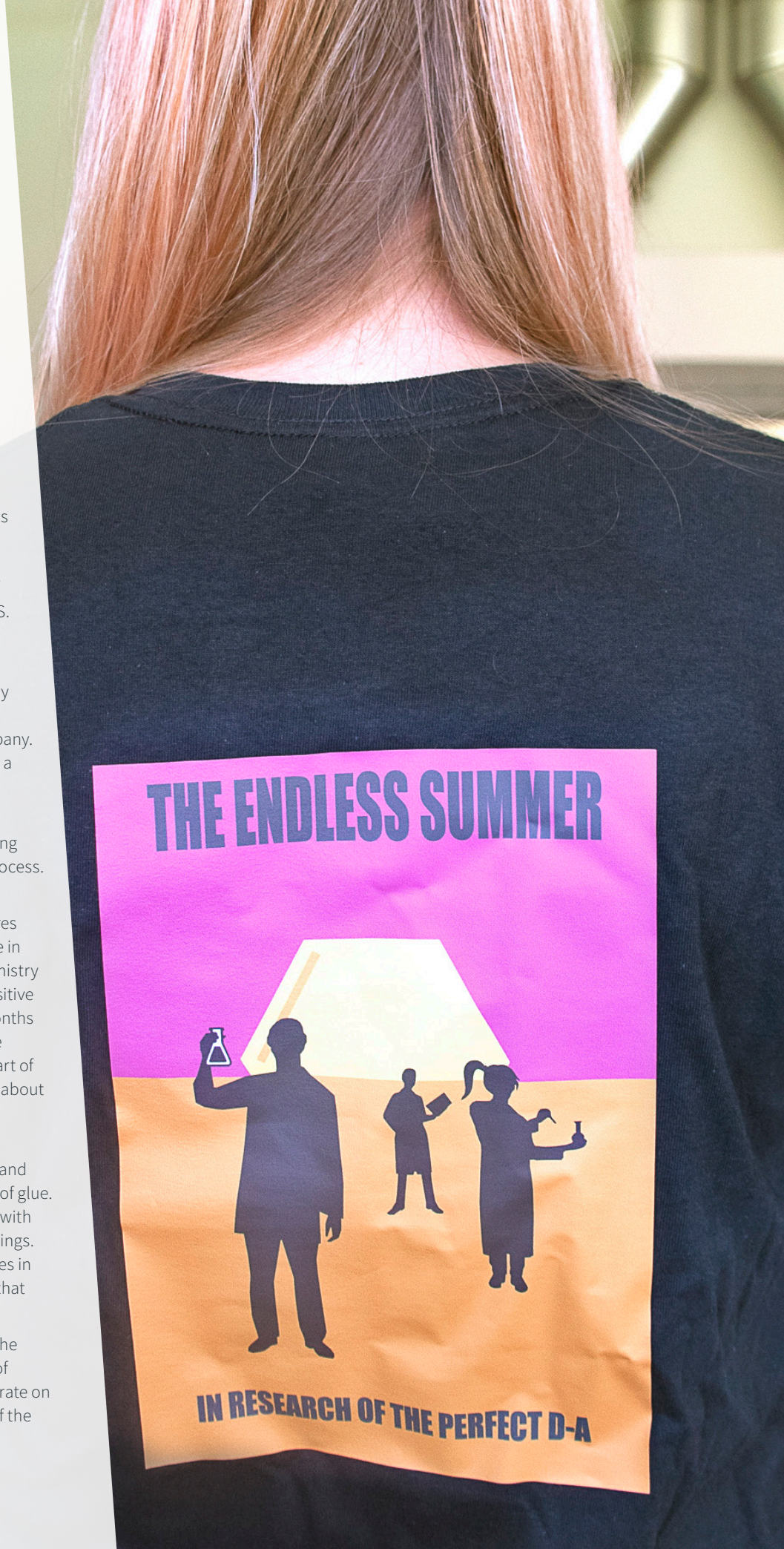
Chemistry professor Philip Costanzo has been developing a new glue in his Cal Poly laboratory in partnership with Geisys Ventures LLC, a technology development and consulting company. Their public-private partnership is the basis for a joint commercial venture.

So far, seven students have been involved in developing the ecology-friendly product, gaining invaluable Learn by Doing experience in the process.

"Working with Dr. Costanzo in undergraduate research and in partnership with Geisys Ventures has been an exciting and rewarding experience in multiple ways," said Taylor Vaughan, a biochemistry major from Ventura, California. "Seeing the positive progression of our project over the last few months has been invigorating. I have really enjoyed the hands-on learning environment and being a part of a fun group of people who also are passionate about chemistry and learning."

Costanzo and Kristoffer Stokes, CEO of Geisys, combined their know-how in polymer science and industrial applications to generate a new type of glue. The technology began its life in Costanzo's lab with applications in bio-based, fully recyclable coatings. Stokes recognized adhesive recycling challenges in the textile and consumer electronics markets that technology could solve.

The material is currently patent-pending, and the two entities recently formed a memorandum of understanding outlining their intent to collaborate on further development and commercialization of the product.



They created the new adhesive as an alternative to low-cost glues frequently used in consumer materials, such as clothing and electronics. Those glues tend to have bonded parts that are permanent, requiring energy-intensive recovery facilities to recycle. Thus, discarded products often end up in landfills.

"The goal is to significantly impact recycling and actually enable the circular economy," Stokes said. "The part of the circle that has been completely neglected is this disassembly part. People talk about recycling plastics or using bio-based materials, but rarely do you hear about disassembly of the item at the end of its life."

Stokes said that adhesives that can be removed require either harmful solvents or extremely hot conditions. Many can't readily be removed without destroying the whole item.

The aim of the Cal Poly-Geisys partnership is to manufacture and market a product that breaks down much more easily.

"This (new Cal Poly) technology will take a durable glue-bonded item, and — after treatment — make the glued parts peel apart like sticky notes," Costanzo said. "We are currently focusing on adhesives in garments but are particularly interested in larger markets like consumer electronics."

Stokes said that many apparel items, including rain jackets, performance athletic wear and even intimate wear, are glued at the seams.

"Often, glue holds dissimilar materials that cannot be recycled together," he said. "By defeating the adhesive, you can break apart this composite and more readily recycle the components."

Students will continue to be part of the technology development with Geisys.

"Students are learning how polymer science can be adapted to make more eco-friendly manufacturing approaches," Costanzo said. "This develops their technical abilities as well as their critical-thinking and problem-solving skills."

The team used existing procedures and materials and incorporated novel chemistry linkages (a sequence of bonds that links one polymer chain to another), referred to as Diels-Alder linkages, into the product. Polymers are substances with large molecules and are the basis of many living organisms and man-made materials.

"The procedure is straightforward, scalable and suitable for completion by undergraduates, which demonstrates the robustness of the system," Costanzo said.

Geisys is planning manufacturing scaleup and exploring further partnerships with selected adhesive manufacturers.

"We are excited to partner with Geisys Ventures on this important technology, highlighting Cal Poly's focus to develop market-transforming technologies with our private sector partners," said Jim Dunning, Cal Poly's associate vice president of corporate engagement and innovation.

LEFT: Costanzo Lab research team members (clockwise from top left) include Taylor Vaughan, Phil Costanzo, Franklin Ng, Ramses Hyde, Noelle Wong, Erik Smith, Adelle Kirshner and Ryan Apel.

ABOVE: Fifth-year chemistry student and Frost Research Fellow Ramses Hyde bonds textiles samples with their adhesive using a heat press.

OPPOSITE: Third-year biochemistry student and Frost Research Scholar Taylor Vaughan wearing a shirt with artwork she designed for the research project

Photos by Izzy Kelly.

Honored Alumni

Roger Duncan

By Nick Wilson

As a biological sciences student at Cal Poly in the early 1980s, Roger Duncan enjoyed an invigorating academic experience bolstered by professors who really "filled my tank and buoyed my confidence to be able to launch for the stars."

Now, in similar fashion, he enjoys giving back so others can fulfill their dreams.

Duncan (Biological Sciences, '84) is vice chief of anesthesiology at Palm West Hospital in Palm Beach County, Florida. His resume is highlighted by significant career accomplishments and leadership in youth and community service.

A champion of education, medicine, diversity and inclusion, and equitable healthcare, Duncan has been named Cal Poly's College of Science and Mathematics Honored Alumnus of 2022-23.

"I'm so appreciative of the Cal Poly professors who were so good to me and really made my college experience a hallmark of who I am," Duncan said. "I certainly want to be an ambassador and tell my story, and Cal Poly planted those seeds for inspiring others. I'm so happy to represent Cal Poly in any way that I can and let others know about what a wonderful foundation it provides that makes you competitive everywhere."

As a leader in his local medical community and beyond, Duncan mentors underprivileged children and advocates for health care by raising hundreds of thousands of dollars in grant funds to best provide access to medical resources.

And his passion for inspiring historically underserved communities to attend college and pursue careers in medicine has been a point of pride for decades.

Looking back at his time at Cal Poly, he recalls his advisor, biological sciences Professor Tom Richards, offering support that helped instill a sense of inspiration and self-belief.

"He filled me with confidence and pointed me in the right direction and just revved me up," Duncan said. "He knew how to dust you off when you stumbled and had this big-time belief that great things can happen. I'm so appreciative."

Duncan said the academic atmosphere at Cal Poly was highly motivational.

"Across from me in Tenaya Hall was a super bright guy, Greg Chamitoff, who went on to become a NASA astronaut; other classmates went on to open their own businesses or become electrical engineers," Duncan said. "It was just a great environment."

Duncan earned a degree from Yale Medical School, where he also performed National Institutes of Health-funded research. He worked with a Nobel Prize winner at the Salk Institute before launching a career in which he sought to advance change for the medically neglected and socio-economically disadvantaged groups.

In Florida, Duncan gives back by dedicating time for holiday events for homeless children, hosts medical career symposiums for high school students and gives lectures to schoolchildren about the importance of science and math. And he founded programs that offer scholarships, symposiums, learning experiences and field trips.

As part of an externship program, eighth graders visit Florida hospitals on a monthly basis, learning professional techniques, taking part in mock drills and familiarizing themselves with instruments such as the Da Vinci robot surgical devices.

He now serves on medical and professional boards, such as the Florida Medical Association Board of Governors; American Heart Association; the T. Leroy Jefferson Medical Society, dedicated to improving health education for underserved populations; and the National Medical Association's Committee on Medical Education. Duncan spoke before the Committee of Diversity and Inclusion at the American Society of Anesthesiologists in 2017.

When he was growing up, his family was among the first Black families to integrate an area of San Diego, facing discriminatory threats such as cross burnings in the yard and rocks thrown through windows of their home. His parents were trailblazing civil rights activists who impressed upon him the values he holds to this day.

"They instilled in us that we had an obligation to take advantage of these opportunities, and not just sit there and file our nails because we lived in a great neighborhood. We had to give back and keep the door open for others, pull others forward and be a beacon to a better way of existence," he said.

> *"We had to give back and keep the door open for others, pull others forward and be a beacon to a better way of existence."*

Duncan, who excelled in high school science classes, sensed that he would enjoy studying biology in college but was still finding his way. His parents suggested other paths, including a career in law.

Arriving at Cal Poly in 1980, he took classes in comparative zoology, botany and entomology — among other science subjects that he found fascinating.

"It really made me know that science was the perfect career for me," Duncan said.

He also fondly recalls participating in student clubs, such as TriBeta, the Biological Honor Society and the Society of Black Engineers, where he served as president.

He recalls club field trips to medical schools across the state and riding his bike to pick up snacks and drinks, bags spilling over with goodies for events.

Duncan has made donations to Cal Poly over the years and has returned to the university with his family, to show them the place that helped launch his journey. He said he'd be proud if his children attended Cal Poly one day.

"I'm really excited to have been asked to become even closer and fortify the relationship of where I started some 40 years ago," Duncan said.

ABOVE: Duncan served as president of the T. Leroy Jefferson Medical Society, which hosted a medical externship program in collaboration with the Good Samaritan Medical Center to educate and inspire young students interested in healthcare careers. ***Photos courtesy of Roger L. Duncan.***

PAST HONORED ALUMNI

The Honored Alumni Award has served as the highest recognition bestowed upon graduates of Cal Poly. Through contributions to their fields and Cal Poly, and through their impact on communities and beyond, our Honored Alumni represent the best of Learn by Doing.

Awardees listed alphabetically with their graduation year.

Michael R. Abbott, '94
Dr. Cheryl Achterberg, '75
William Jay Alison, '77
Dale Walker Andrews, '52
Philip S. Bailey, Jr.
Diana Blake Barnhart, '68
Isaac Ruben Barpal, '67
Bobby Beathard, '59
Nanci L. Bell, '65
Anne Marie Bergen, '85
Barbara Lynn Blanke, '85
Linda McArther Bradford, '71
Richard John Bradshaw, '70
Howard W. Braham, '72
Gary John Brusca, '60
David Raymond Burgess, '72
Arlene B. Chandler, '63
Lewis Alvin Cryer, '66
Agustin Jaime Cuello, '93
L. Byron Culver, Jr., '50
Peter J. Cutino, '57
Nancy Lee DePue, '67
Kenneth E. Dyar, '89
William Howard Fenical, '64
Gerald Alvin Fialho, '55
Sally Vreseis Fox, '79
William Lee Frost, '72
Tim Geistlinger, '92
Daniel Charles Fulmer, '71
Brian J. Hackney, '86
Margaret Jane Hartman, '66
John Peterson Hartnett, '61
H. Vincent Jacobs, '65
Jeffrey R. Jasper, '84
Harold Arden Kurth, '59
Hugo Ernesto Lara, '89
Brian Philip Lawler, '76
William Robert Livesay, '67
John Earl Madden, '59
Charles Robert Manclark, '53
John Thomas McDevitt, '82
Christina H. McEnroe, '00
Michael R. McGinnis, '66
David H. Montgomery, '54
Geraldine Owen Montgomery, '72
Candice Ann Morgan, '69
Don Monte Morris, '52
Dorothy Elaine Newell, '77
Mark J. Newland, '82
Edward Wayne Newton, '63
Nohemy Ornelas, '07
Charles Ward Patterson, '62
Gordon Lee Ray, '53
Peter Jacob Reitz, '60
Robert B. Samules, '61
Eric E. Schadt, '91
Carolyn Baggerly Shank, '69
Michael Parker Sherman,'65
Glenn R. Stewart, '58
Gilbert H. Stork, '64
Robert Raymond Treanor, '67
Richard Chester Tucker, '60
Gail G. Uilkema, '75
John Waggoner, '89
Walter William Wilson, '65
Dianne Wilson-Graham, '79
James T. Woolaway, '82

Faculty of Quality and Excellence

Distinguished Teaching & Scholarship Awards to CSM Faculty

By Nick Wilson

Three Cal Poly College of Science and Mathematics faculty received honors this year for outstanding performance as teachers and scholars.

Chemistry Professor Phil Costanzo and biological sciences Professor Nishanta "Nishi" Rajakaruna earned Distinguished Teaching Awards.

> *"We're very proud of their commitment to robust Learn by Doing opportunities and top-notch instruction and research."*

Rajakaruna also earned the Distinguished Scholarship Award, along with kinesiology and public health Professor Alison Ventura.

The recognition for Rajakaruna marks the first time in Cal Poly's history that a faculty member earned two universitywide awards in the same year. The awards are determined by Academic Senate committees.

"These achievements are exemplary of excellent work and drive to continue to improve, connect and contribute," said Dean Wendt, dean of the College of Science and Mathematics. "We're very proud of their commitment to robust Learn by Doing opportunities and top-notch instruction and research."

Alison Ventura

Ventura's research and expertise focuses on early childhood nutrition, family interactions and obesity prevention. Her work aims to understand how early experiences can affect eating behaviors, dietary patterns and weight status throughout a person's life.

"I really enjoy contributing to the science that can help parents and families," Ventura said.

Ventura holds degrees in human development and family studies nutrition and in psychology. She has taught at Cal Poly since 2014.

"I'm very interested in early interactions during feeding between parents and children and how these interactions may shape both parents and children," Ventura said. "The implications of these early interactions may affect a child's development and the family's interactions and health outcomes."

Many undergraduates serve as her research assistants, providing both the students and Ventura with valuable experience.

"Students get a really robust research experience and learn state-of-the-art methods for understanding infant behavior, family interactions and early health outcomes," Ventura

said. “And I personally have really appreciated all I’ve learned about early development and how to raise children, which has immensely benefited me as both a mother and mentor to emerging adults.”

Ventura has authored over 60 scientific publications and two books and works closely with the federally funded Special Supplemental Nutrition Program for Women, Infants and Children (WIC).

Her research projects have received grant funding from the National Institutes of Health and the Robert Wood Johnson Foundation Health Eating Research program. Ventura also has received support from Cal Poly’s Frost Fund. Her recently published academic book, "Promoting Responsive Feeding During Breastfeeding, Bottle-Feeding, and the Introduction to Solid Foods," was released in August.

“Fortunately, the field of infant feeding is receiving a lot of attention right now because we haven’t had formal dietary guidelines for this population up until this current iteration of the dietary guidelines,” Ventura said. “Early childhood nutrition is a real public health priority, which makes it an exciting time to be conducting research with young children and their families.”

Phil Costanzo

A chemistry professor with 15 years of experience at Cal Poly, Costanzo won the Distinguished Teaching Award.

Costanzo teaches classes such as Organic Chemistry and Chemical and Biological Warfare, an upper-division elective that is popular among students.

Costanzo has grown the most in his instruction over the past five to six years, he said.

“As you move up the ranks of faculty, you start evaluating your peers and that, to me, has been the most valuable component,” Costanzo said. “Observing peers has helped offer ideas and led me to try different techniques, which has been super helpful.”

Being forced into remote teaching and learning due to COVID-19 precautions also was an impetus to improve.

“It forces you to think about your strategies, methods of engagement and classroom techniques, and I think that also really played a big role,” he said.

Costanzo’s research lab has received direct contributions from more than 105 students. Their efforts have resulted in 21 peer-reviewed publications, two patents and more than 130 presentations.

As of summer 2022, Costanzo’s research to develop a new eco-friendly glue in collaboration with the East Coast company Geisys had involved seven student researchers with plans for ongoing student involvement. The patent-pending novel adhesive is launching as a commercial product.

“Students are learning about how polymer science can be adapted to make more eco-friendly manufacturing approaches,” Costanzo said. “This develops their technical abilities as well as their critical-thinking and problem-solving skills.”

Nishi Rajakaruna

A biological sciences professor who specializes in botany, Rajakaruna dedicates himself to educating students, making connections and encouraging exploration.

Rajakaruna has enjoyed the mixture of teaching, research and mentoring since he joined Cal Poly in 2017.

“The research component is very student-driven and student involved,” Rajakaruna said. “I don’t necessarily feel like there is a line where teaching ends and research begins. It’s a continuum.”

Rajakaruna specializes in the study of plants and lichens found on serpentine and other harsh soils and provides students with research opportunities in California and beyond.

“Students who enroll in my classes often become my research students, and we publish together, we go to conferences together and they get to know my collaborators from across the world,” Rajakaruna said. “It’s a really cool network that we have been building over the years.”

In 2022-23, he will further his research on serpentine ecology at North-West University in South Africa, thanks to a Fulbright U.S. Scholar Award. At North-West, he’ll collaborate with students and scientists and give seminars throughout South Africa.

Fourth-year biological sciences student T.J. Samojedny will join Rajakaruna at the end of the year to help with the research taking place in South Africa.

“I have really enjoyed the opportunities that I have had to work with students both in and outside the classroom at Cal Poly and connecting my current students with former students at other universities where I’ve worked previously, especially when their interests overlap,” Rajakaruna said. “They may be 10 or so years apart, but they often strike up really exciting and productive partnerships along the way.”

Rajakaruna, who won the university’s Outstanding Faculty Advisor Award in 2019-20, said that Cal Poly is really good at recognizing service.

“I feel like people are paying close attention to what’s going on around campus,” said Rajakaruna. “It’s very humbling and supportive to be appreciated in this way.”

Facts & Figures

ABOUT THE COLLEGE OF SCIENCE AND MATHEMATICS

STUDENT SUCCESS

ACCEPTANCE RATE

The acceptance rate for incoming first-year students is **35%**.

DEGREES

12 undergraduate degrees
10 graduate degrees
5 post-baccalaureate credentials
11 minors

GRADUATION RATE

85% graduation rate (six-year).
600 bachelor's degrees awarded.*
**Most recently available data is from 2019-20.*

UNDERGRADUATE RESEARCH

STUDENT FUNDING

$1.4 million paid to undergraduates for doing research annually.

PROFESSIONAL EXPERIENCE

237 undergraduate students co-authored **215 scholarly publications** with their faculty mentors in the last two years.

MENTORSHIP

Nearly **400 undergraduate students** engaged in faculty-mentored research projects during summer, and more than **800** during the academic year.

MORE THAN
50%
of first-year students are paired with a peer mentor.

APPROXIMATELY
52%
of CSM publications were co-authored by undergraduates in 2021.

MORE THAN
50%
of students engage in undergraduate research each academic year.

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RESPECT
#mustangsUNITED

The College of Science and Mathematics strives to empower all students, faculty and staff to succeed in a diverse and inclusive community that values respect, equity and social justice.

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Morgen Marshall
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The south entrance to the William and Linda Frost Center for Research and Innovation features a wall faced with bricks spelling out "Discere Faciendo" — Learn by Doing in Latin.

Photo by Izzy Kelly