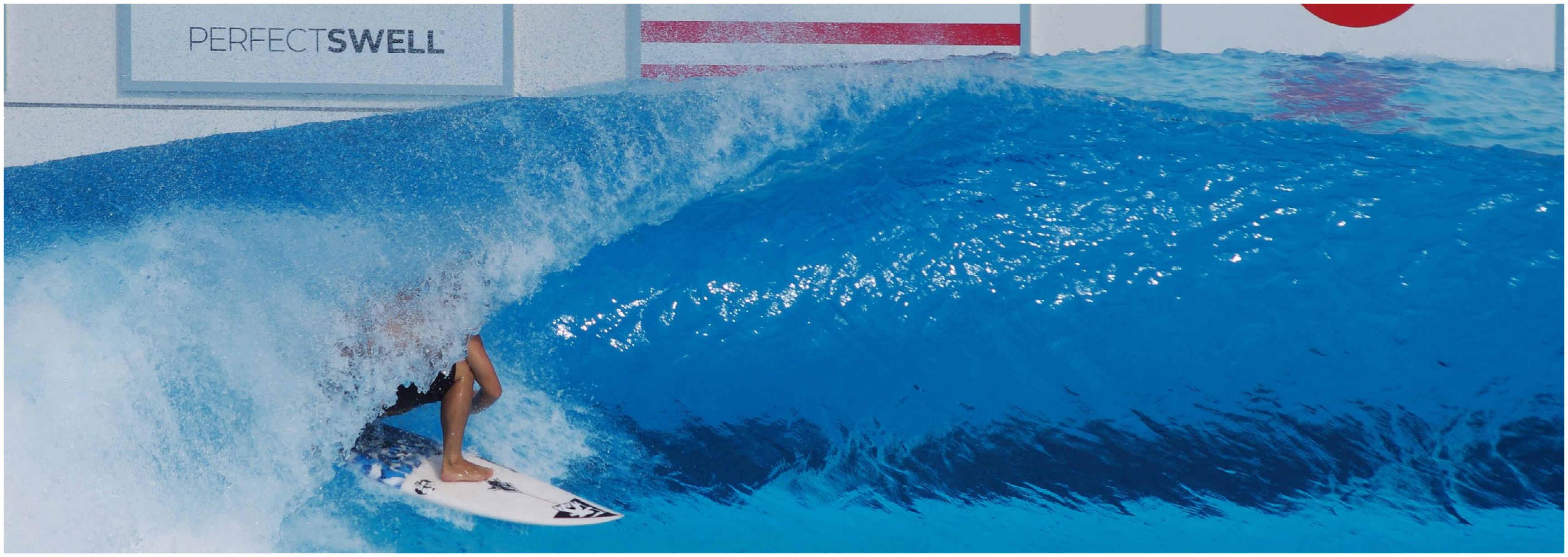
NEWS BRIEFS



Masatoshi Ohno gets "barreled" thanks to a PerfectSwell wave machine at the Shizunami Surf Stadium, in Shizuoka, Japan.

MAKING WAVES

Ever since he was a teenager surfing along the Los Angeles County coast, **Bruce McFarland** (BS/MS '81) has been searching for the perfect wave. Now, more than forty years after graduating from UC Santa Barbara with degrees in mechanical engineering, he is making waves with his wife, **Marie** (BS, '80) and bringing them to surfers around the world.

The couple began developing the technology in 2000, after establishing careers in the aerospace industry — and having three children along the way. The operation was initiated when Bruce constructed a small-scale model to produce standing waves in his backyard shed. He then moved on to build a larger-scale model and a prototype.

Nearly twenty years later, their company, American Wave Machines (AWM), has emerged as a global leader in artificial waves. Their first patented technology, SurfStream, is now featured in fifteen facilities worldwide. Their second, known as PerfectSwell, is used in surf pools in Japan, New Jersey, Texas, and the largest, a six-acre pool in Brazil. Surfers from the U.S. and Japan trained for the Tokyo Olympics in one of their pools.

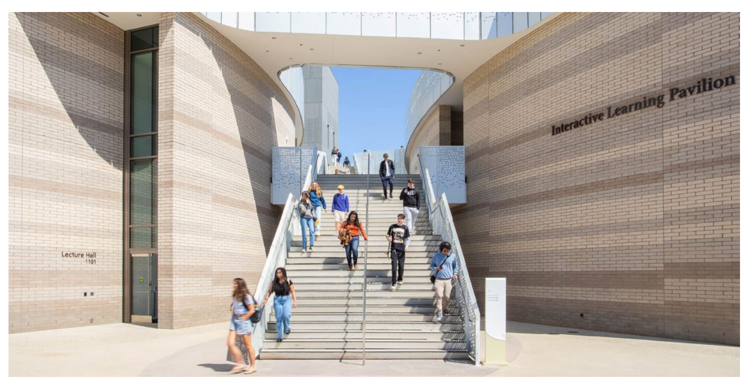
Bruce's waves are produced by an air-over-water system, in a process similar to how a piston acts in a car engine. "You have a chamber connected to a pool that is separated by a wall, with water on both sides," he says. "You create waves when the water travels under the wall to get into or out of the pool, which happens when you add pressure into the chamber."

The technology allows for customized waves: some peel like a point break, while others have multiple "barrel" sections.

Bruce credits his and Marie's UCSB education and their time working with computer-aided technology in the aerospace industry for their ability to ride an artificial wave of success, saying, "We owe a lot to UCSB, including finding one another."

NEW CLASSROOM BUILDING OPENS

The Interactive Learning Pavilion (ILP), the first UC Santa Barbara building dedicated to classroom space in more than fifty years, officially opened its doors on the first day of spring classes. Located next to the BioEngineering Building, the ILP is organized into three buildings, with a courtyard between them to allow for foot traffic. The four-story structure features five tiered lecture halls, twenty classrooms equipped with state-of-the-art technology, three project-based learning rooms designed to facilitate team learning, two group-study rooms, and multiple outdoor seating and study areas. The state-funded project increased the campus's classroom seating capacity by 2,000 seats, or 35 percent, and created an additional 1,800 bicycle parking spaces.



The new Interactive Learning Pavilion at UCSB.

BEATING "UNTREATABLE" BUGS

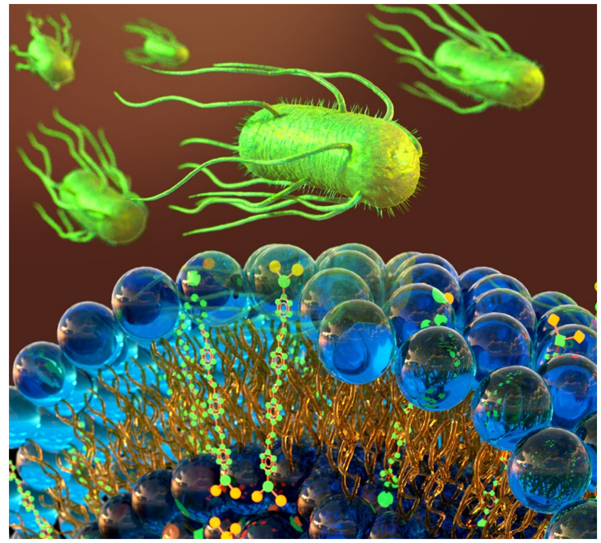
A study by a team of UC Santa Barbara scientists published in the February 15 issue of the journal *eBioMedicine* and titled "A Broad-spectrum Synthetic Antibiotic That Does Not Evoke Bacterial Resistance," describes a new drug that could be a game changer for the treatment of antibiotic-resistant "superbugs." The team developed a new class of antibiotics that cured mice infected with bacteria deemed nearly untreatable in humans.

The project was led by professors **Michael Mahan, David Low, Chuck Samuel** (all in the Molecular, Cellular and Developmental Biology Department) and their research team, with additional contributions from UCSB professor **Guillermo Bazan** (Chemistry) and Andrei Osterman, of the Sanford Burnham Prebys Medical Discovery Institute in San Diego.

The discovery was serendipitous. The U.S. Army had a pressing need to charge cell phones while in the field — essential for soldier survival. Bacteria are miniature power plants, so Bazan's group designed compounds to harness their energy as a "microbial battery."

Asked to consider whether the compounds could serve as antibiotics, the team thought that they would be highly toxic to human cells, said Mahan, the project lead. "Most were toxic, but one was not, and it could kill every bacterial pathogen we tested."

"The key finding was that bacterial resistance to the drug was virtually undetectable," said lead author **Douglas Heithoff,** senior scientist at the UCSB Institute for Collaborative Biotechnology. "Most drugs fail at this stage of development and never get to clinical practice."



Artist's depiction of the new synthetic antibiotic interacting with refractory bacteria. Illustration by Ryan Allen and Peter Allen, Second Bay Studios

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JUNIOR COE AND STEM FACULTY ARE OWNING

UC Santa Barbara ranks #1 among public universities in the percentage of eligible junior faculty who have received an Early CAREER Award, the National Science Foundation's most prestigious award for young faculty.

OVERCOMING RESISTANCE

For people who study fluid mechanics, like UC Santa Barbara mechanical engineering professor **Paolo Luzzatto-Fegiz**, drag, or the resistance between an object moving through fluid or, conversely, a stationary object that has fluid flowing around or through it, is a big deal. In trying to develop superhydrophobic surfaces (SHS) — seen as a potential solution to the problem of drag, which reduces the efficiency of things like cargo ships and increases the energy expenditure of, say, pumping liquids through pipes — Luzzatto-Fegiz and his collaborators developed a theory addressing what he calls a "messy problem," identifying ten parameters for an effective SHS. It turns out, according to research published January 12 in the *Proceedings of the National Academy of Sciences*, that one of them is by far the most important.

The same superhydrophobicity that makes plants like kale shed water, thanks to microscopic surface structures that create tiny pockets of air, could reduce drag on inanimate surfaces. But surface patterning turned out not to have the desired effect. The fly in the ointment of flow was surfactants, unavoidable compounds that reduce the tension between the water and the air in the bubbles, negating the performance of an SHS.

The researchers found the most important parameter to be the length of the air bubbles. Simply put, the longer the tiny grating that generates the air pocket was, the less effect the surfactant molecules had. There appears to be a critical air-pocket length, which depends on the surfactant type and concentration. "If you make the grating about ten centimeters long, the surfactant can't quite do its thing of resisting the fluid motion," Luzzatto-Fegiz says. "And you could get this ideal drag reduction that people have been angling for, for twenty years."

Microscopic structures that form pockets of air, making some plants naturally hydrophobic, are key to developing superhydrophobic surfaces.

SUMMIT OF SUCCESS

Six months of working in teams to conceptualize, design, test, and present capstone projects culminated this spring for dozens of students during summit.cs, the UC Santa Barbara Computer Science Department's annual capstone event. A two-course sequence gives seniors the opportunity to develop innovative solutions to real-world problems by working with classmates and industry partners.

Judges awarded first place to Tranquilitea, second place to Fat Stacks, and third place to Oversea. Working with industry partner Artera, Tranquilitea created an application to address an important aspect of the mental-health crisis, specifically around anxiety. The technology incorporates the use of wearable technology, medical data, and artificial intelligence to identify when a user is starting to feel anxious. When that happens, the biometrics prompt an AI chatbot to offer breathing exercises and other techniques to provide support and reduce stress.

Partnering with Allthenticate, Fat Stacks created a mobile authentication app that allows users to quickly log into pre-registered websites by authorizing the attempts on their phone, rather than manually entering their usernames and passwords on websites. Third-place winner, Oversea, created a platform to help naval personnel repair specialized equipment on ships. The team designed software that uses artificial- and virtual-reality technologies to provide remote maintenance.

They "summited" (from left): Professor Giovanni Vigna; Judges Jeremy Smith and Ben Mercier; Tranquilitea members John Rollinson, Samar Kahn, Heather Dinh, Victoria Reed, and Archana Neupane; Judges Randy Modos and Zoran Dimitrijevic.

REDEFINING THE PATH TO FACULTY

S. Shailja, a fifth-year PhD student in UCSB's Electrical and Computer Engineering (ECE) Department, recently earned a unique opportunity to participate in a federally funded program designed to diversify ECE faculties nationwide. She attended a two-day workshop, ImpRoving thE DivErsity of Faculty IN Electrical and Computer Engineering (iREDEFINE), during the ECE Department Heads Association Annual Conference in New Mexico. Supported by the National Science Foundation, the workshop brings department heads together with women and underrepresented minorities to provide a glimpse of the career of an ECE faculty, tips on how to prepare for a successful faculty interview, and networking opportunities.

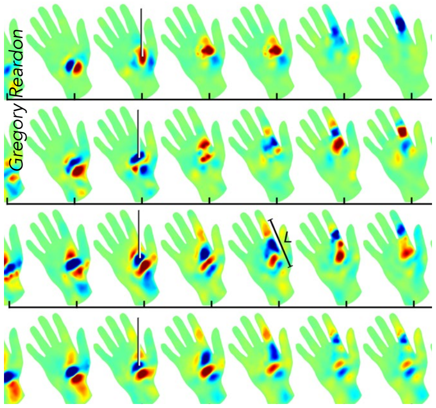
"The iREDEFINE workshop was a great source of motivation and confidence, [showing me] that my research was being recognized and appreciated," Shailja said of the experience. "I met fellow PhD candidates, and we formed a supportive community of like-minded individuals. It has inspired me to continue pursuing a career in academia."

S. Shailja

Advised by **B. S. Manjunath,** chair of UCSB's ECE Department, Shailja builds mathematical tools for modeling neuronal fibers in human brains as geometrical objects in three-dimensional space. Modeling connectivity of the human brain is critical to understanding and treating neurological disorders such as Alzheimer's disease and strokes.

During the workshop, Shailja received valuable advice from department heads during mock faculty interviews and was even invited to apply for open faculty positions at their institutions.

HONING HOLOGRAPHIC HAPTIC DISPLAYS



Measured skin oscillations in response to an ultrasound focal point scanned at different speeds.

Holographic haptic displays rely on what are called *phased arrays* of ultrasound emitters to focus ultrasound in the air, allowing users to touch, feel, and manipulate three-dimensional virtual objects in mid-air using their bare hands — without the need for a physical device or interface.

While such displays hold great promise for use in a range of application areas, the tactile sensations that they currently provide can feel like "a breeze or a puff of air," according to **Yon Visell**, associate professor in the UC Santa Barbara Mechanical Engineering Department. A new study from his lab explains why such holograms feel, as he says, "much more diffuse or indistinct than would be expected."

In a paper titled "Shear shock waves mediate haptic holography via focused ultrasound" and published in the March 1 issue of the journal *Science Advances,* Visell and PhD student researcher **Gregory Reardon** describe discovering the reason for such insubstantial sensations.

In haptic holography, Visell explains, focusing and scanning ultrasound waves in mid-air creates shock waves, which, in turn, cause vibrations on the skin. Vibrations resulting from this previously unknown shock-wave phenomenon can interfere with each other in a way that amplifies their strength at some locations, but can also create a trailing wake pattern that extends beyond the intended focal point, reducing the spatial precision and clarity of the tactile sensations. Current holographic haptic displays excite shock wave patterns that are so spread out on the skin that the sensations feel diffuse and indistinct.

"Our study reveals that new knowledge in acoustics is needed to spur innovations in the designs of holographic haptic displays," Visell said. "By understanding the underlying physics of ultrasound-generated shear shock waves in the skin, we hope to improve the design of such displays and make them more realistic and immersive for users. "

THE BREAKDOWN ON LIGNIN

Lignin, the structural biopolymer that gives stems, bark, and branches their signature woodiness, is one of the most abundant terrestrial polymers on Earth, surrounding valuable, energy-rich plant fibers and molecules that could be converted into biofuels and other commodity chemicals — if only we could get past that rigid plant cell wall.

For some years, UC Santa Barbara chemical engineering professor **Michelle O'Malley** has been working on how to accomplish that outside of the guts of large herbivores, where the process occurs automatically thanks to the actions of anaerobic microbes. Researchers in O'Malley's lab have now identified a group of anaerobic fungi, called Neocallimastigomycetes, that can do the job.

The results of the collaboration connecting O'Malley with colleagues at the U.S. Department of Energy Joint Genome Institute, the Lawrence Berkeley National Laboratory, the Joint BioEnergy Institute, and the Great Lakes Bioenergy Research Center, were published as the cover article of the April 1 issue of the journal *Nature Microbiology.*

In the project, lead author **Tom Lankiewicz**, who completed his PhD in Life Sciences at UCSB in December 2022, cultivated some fungi in the Neocallimastigomycetes group that O'Malley had used previously, growing them on poplar, sorghum, and switchgrass in an oxygen-free environment. Using advanced imaging techniques, the team was able to identify specific lignin-bond breakages caused by Neocallimastix californiae in the absence of oxygen — evidence of the anaerobic breakdown of lignin.

"This is a paradigm shift in terms of how people think about the fate of lignin in the absence of oxygen," O'Malley said. "You could extend this to understand what happens to lignin in a compost pile, in an anaerobic digester, or in very deep environments where no oxygen is available. It pushes our understanding of what happens to biomass in these environments and alters our perception of what's possible and the chemistry of what's happening there."

Goats and other large herbivores break down lignin naturally, thanks to anaerobic gut fungi.

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CAN YOU HEAR ME NOW?

In her first journal paper, written in 1999, UC Santa Barbara computer science professor **Elizabeth Belding,** then a PhD student in electrical and computer engineering, and co-author Charles Perkins of Sun Microsystems introduced a novel means of routing data packets in mobile networks. That work helped set the stage for networking in the then-nascent mobile ad hoc and mesh networks and has heavily influenced the development of the research field. The paper received the 2018 ACM SIGMOBILE Test-of-Time award and recently hit the 30,000-citation mark, an unusual achievement, as only 16 papers by UCSB professors have received more citations.