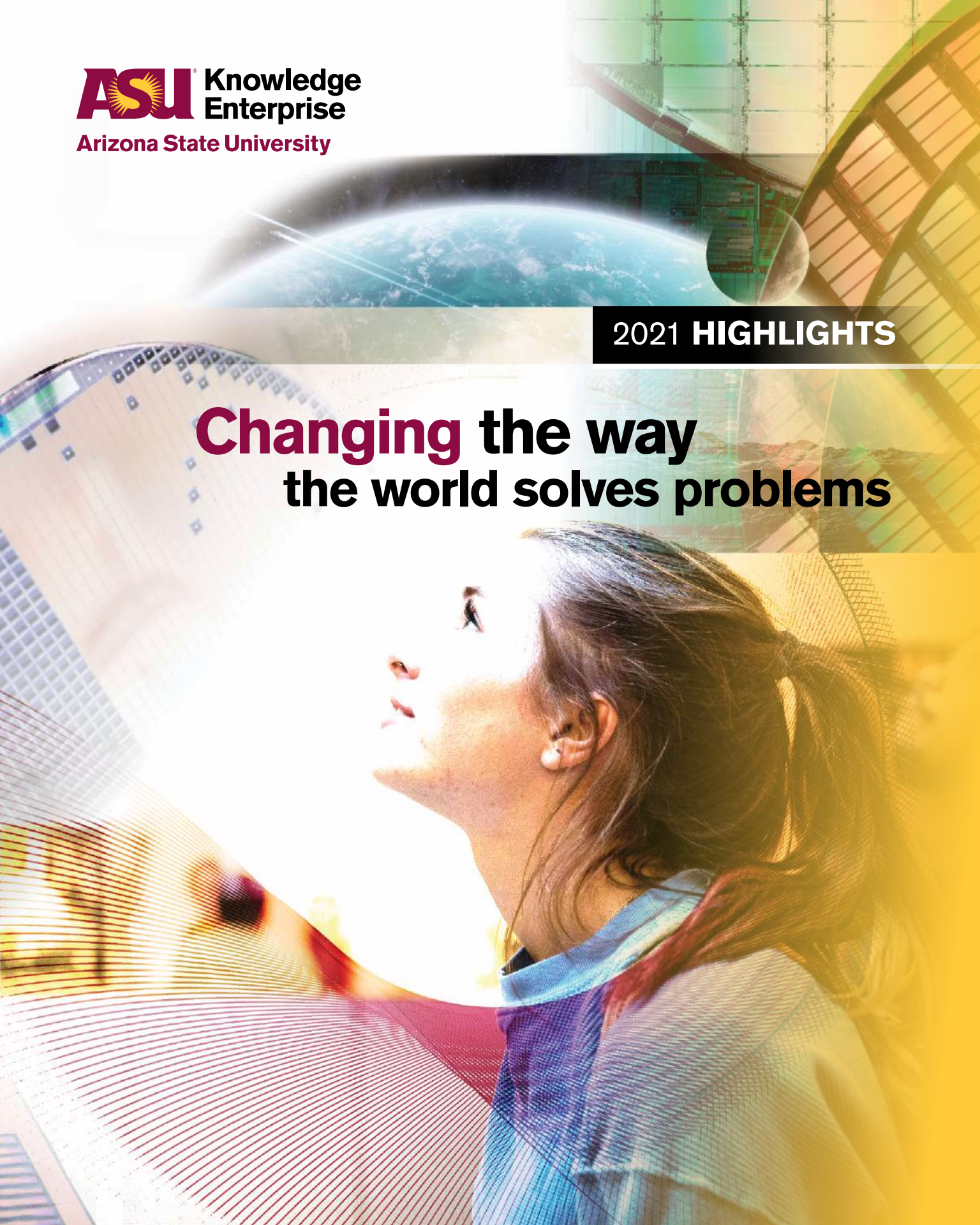
ASU Knowledge Enterprise
Arizona State University

2021 **HIGHLIGHTS**

Changing the way the world solves problems



“Knowledge Enterprise embodies a new paradigm of solving global challenges at scale. The research and innovation engine of Arizona State University brings people together across disciplines and empowers faculty, staff, students, partners and our community to conduct research and translate solutions into impact. Knowledge Enterprise responds with speed, agility and flexibility, and our ambition is nothing less than changing the way the world solves problems.”

— Sally C. Morton, executive vice president, ASU Knowledge Enterprise
Morton joined the university in February 2021.

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Exploring our universe

Office space

ASU is working with Blue Origin to create a business park in orbit.

A mixed-use business park in space may sound like a daydream of the distant future, but Arizona State University is partnering with Blue Origin and other space industry leaders to create one by the end of this decade.

Dubbed Orbital Reef, the pioneering space station will make its home in low Earth orbit (LEO) and offer the infrastructure to support new markets in space, including research, manufacturing, travel, education and exploration. And it's not just for specialists.

> **"Throughout the 20th century, space exploration has been the realm of the hero, the unreachable astronaut, the one special person. But with Orbital Reef, we will make it accessible for so many more people who can participate in many different ways. This is our moment to bring everyone into space exploration."**
>
> — Lindy Elkins-Tanton, vice president, Interplanetary Initiative; professor, School of Earth and Space Exploration

NASA selected Orbital Reef, led by Blue Origin, to design a space station in low Earth orbit through a funded Space Act Agreement in the amount of $130 million. NASA's Commercial LEO Development program aims to shift NASA's research and exploration activities in LEO to commercial space stations, helping stimulate a growing space economy before the International Space Station is retired.

Announcing Orbital Reef: Your address in orbit

Arizona State University is partnering with Blue Origin to create Orbital Reef, a mixed-use space station for commerce, research and tourism.

A rendering of the Orbital Reef space station. Image courtesy of Blue Origin Media

Just like Earth-side business parks, Orbital Reef will provide a shared facility that different entities can lease and use to serve research, government, industrial, international and travel customers. It will be like a village, where people from many organizations can carry out their activities separately and interact with each other. By offsetting the complexity and cost of living and working in low Earth orbit, Orbital Reef opens the space economy to a wider array of small businesses, projects and nations.

The Orbital Reef destination will be backed by industry leaders and teammates including Sierra Space, Boeing, Redwire Space and Genesis Engineering.

ASU's Interplanetary Initiative leads the Orbital Reef University Advisory Council — a consortium of more than a dozen international universities. The group will establish guidelines and standards of conduct for ethical research on the station, provide consulting for those new to space research, channel academic research onto Orbital Reef, inform the academic user experience aboard the station, and conduct STEM outreach and education programs.

Interplanetary Initiative is building a positive future of humans in space that benefits society both on- and off-planet.

ASU Interplanetary Initiative:
Advancing society through exploration

"Shifting our mindset to see ourselves as a team of crewmates aboard a space vessel — Earth — opens the door to shared purpose and better cooperation," says Jessica Rousset, deputy director of Interplanetary Initiative.

The initiative works to identify key needs for human success in space and then form interdisciplinary teams to solve them. This includes collecting insights from the humanities and social sciences as well as traditional STEM fields and inviting diverse voices to help set the course toward an equitable tomorrow. Additionally, the initiative creates public-private partnerships so that any group or industry can be part of shaping this space future.

The initiative is also home to a 6,800-square-foot lab that functions as a research and development workspace. There, external partners connect with ASU students, faculty and staff to design, build and test space hardware and software. Giving students the chance to gain experience working with this technology supports the development of a robust workforce for the growing space industry — and forges a path for more endeavors like Orbital Reef.

At the heart of the Interplanetary Initiative's current research are questions like: How can we sustain healthy communities in space? How will we manage shared resources in space, from satellites and space debris to minable asteroids? How can we better connect humans and robots in space exploration? And how would humankind react to the discovery of alien life? Finding answers will help prepare us to play a role in space that benefits the people of our own planet.

"Humans are compelled to explore. It's in our bones. We will become an interplanetary species," says Lindy Elkins-Tanton, vice president of the Interplanetary Initiative. "We have an opportunity to use the inspiration of space exploration to take better care of the Earth by involving all of society and driving technological advances that will help solve problems here below." ■

ASU NewSpace helped facilitate a collaboration between an ASU researcher and World View that landed a competitive Flight Opportunities award from NASA.
Photo courtesy of World View.

Team me up, Scotty!

As the only university on the executive board of the Commercial Spaceflight Federation, ASU is boldly going into a new era of space exploration — one of powerful public-private partnerships. In 2013, ASU launched the Space Technology and Science Initiative (NewSpace for short) to forge partnerships between industry and academia to meet NASA's ever-evolving needs.

The following are a few ASU collaborations innovating at warp speed:

- A researcher in ASU's School of Earth and Space Exploration is working with Tucson-based World View to create a lighter, more energy efficient water sensor for weather balloons, which could potentially be used on space missions as well. The project is funded through a NASA Flight Opportunities award.

- ASU's MILO Space Science Institute has teamed up with the Trade Commissioner Service of Canada (TCS) to develop the Canadian Space Payload Accelerator. Open to Canadian companies and STEM faculty and students, the accelerator will help teams develop payloads that meet the science goals for returning humans to the moon on NASA's Artemis III mission. MILO is a nonprofit research collaborative led by ASU with support from Lockheed Martin. The TCS is supported by the Canadian Space Agency.

- Like mountain climbers roped together for safety, robots can accomplish more when tethered to each other than they can on their own. An ASU engineering researcher is working with Tethers Unlimited, a small aerospace company, to coordinate these robot teams in navigating terrain. The work led to a distinguished 2020 Early Career Faculty Space Tech Research Grant from NASA. ■

Space mission updates

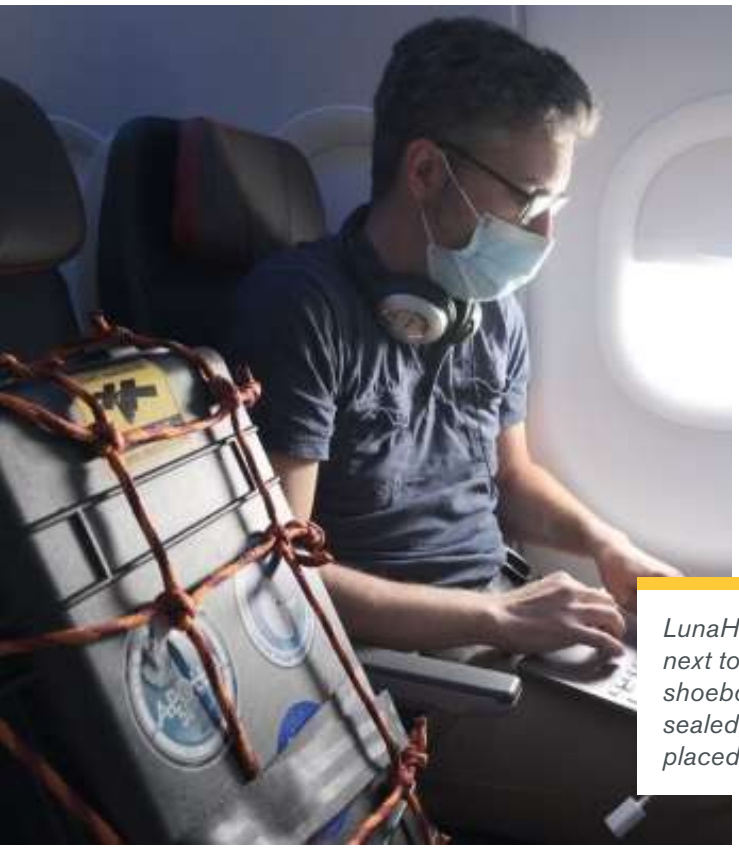
Lucy's in the sky

NASA's Lucy mission, which will explore the Trojan asteroids in the outer solar system, launched October 16 from Kennedy Space Center in Florida. The spacecraft is named for the 3.2-million-year-old human ancestor fossil, "Lucy," discovered in 1974 by Donald Johanson, founding director of ASU's Institute of Human Origins. Aboard the spacecraft is the ASU-led instrument, Lucy Thermal Emission Spectrometer (L'TES), which will help the Lucy team learn about the composition and structure of material on the surface of the asteroids. ASU is also participating in the Lucy mission through the innovative NASA L'SPACE Academy, a free, online, interactive program for undergraduate students interested in pursuing a career with space organizations.

Mars rover reveals a watery past

Jezero Crater today is a dry depression on the Martian surface. But billions of years ago, it held a lake fed by a 120-mile-long river, according to detailed images from the Perseverance Mars rover. The images were captured by the ASU-led Mastcam-Z cameras, as well as the rover's remote micro-imager. They provide insight into where the rover could best hunt for rock and sediment samples to bring back to Earth — samples that might contain evidence of past life on Mars. The rover science team published their results in the journal Science in October.

Images from the Perseverance Mars rover, NASA's six-wheeler on the Red Planet, reveal that Jezero Crater once contained a lake with a fan-shaped river delta that experienced late-stage flooding events.



LunaH-Map is launch-ready

The ASU-led team that built NASA's Lunar Polar Hydrogen Mapper, or "LunaH-Map" for short, has safely delivered their spacecraft to NASA's Kennedy Space Center in Florida in preparation for a launch expected in 2022 on NASA's Space Launch System (SLS) Artemis I rocket. LunaH-Map is the first NASA mission to be led, designed, assembled, integrated, tested and delivered from the ASU Tempe campus. Its destination is in orbit around the moon. From there it will map water-ice in permanently shadowed regions of the lunar south pole. ■

LunaH-Map gets its own seat on the flight to Florida, next to principal investigator Craig Hardgrove. The shoebox-sized spacecraft was packed in a doubly sealed, nitrogen-filled, electrostatic-safe bag, then placed in a crushproof and dustproof foam-lined case.

02 Protecting our planet

A desert university dives deep into oceans research

Our planet's oceans are home to more than 2 million different species of plants, animals and microorganisms. In addition, over 3 billion people rely directly on these waters for their livelihoods. Not only do oceans sustain billions of life forms, but they are also closely intertwined with Earth's climate. When our oceans are in decline, the entire planet suffers the consequences.

In response to the mounting threats to our climate's health, ASU's Julie Ann Wrigley Global Futures Laboratory™ has extended its reach beyond the desert to develop global partnerships with many of the world's top oceans-based research institutions and organizations.

ASU's partnership with BIOS

Learn how ASU's partnership in Bermuda expands educational and research opportunities.

Coral cartography

Among ocean ecosystems, coral reefs are the megacities, supporting more species per unit of area than any other marine environment. Coral reefs serve the important role of protecting coastlines from storms and erosion. They are also essential to communities on the coastline, providing a source of food and economic gains from tourism.

The Global Futures Laboratory's Center for Global Discovery and Conservation Science announced the completion of the Allen Coral Atlas in September 2021, creating the world's first comprehensive map of shallow water coral reefs.

"Our biggest contribution in this achievement is that we have a uniform mapping of the entire coral reef biome. If you don't know what you've got more uniformly, how would the U.N. ever play a real role? How would a government that has an archipelago with 500 islands make a uniform decision? [The atlas] lets us bring the playing field up to a level where decisions can be made at a bigger scale because so far decisions have been super localized."

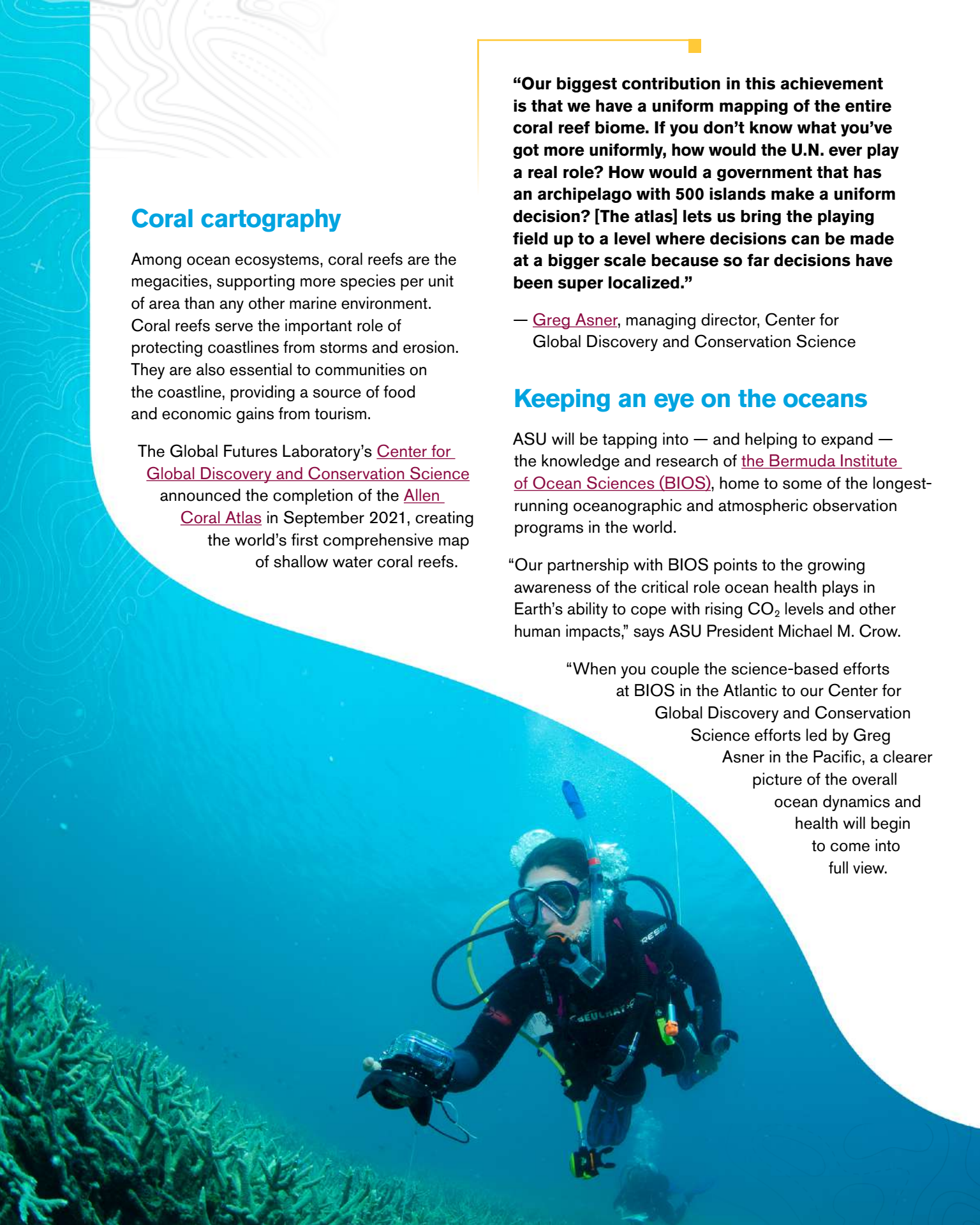
— Greg Asner, managing director, Center for Global Discovery and Conservation Science

Keeping an eye on the oceans

ASU will be tapping into — and helping to expand — the knowledge and research of the Bermuda Institute of Ocean Sciences (BIOS), home to some of the longest-running oceanographic and atmospheric observation programs in the world.

"Our partnership with BIOS points to the growing awareness of the critical role ocean health plays in Earth's ability to cope with rising CO_2 levels and other human impacts," says ASU President Michael M. Crow.

"When you couple the science-based efforts at BIOS in the Atlantic to our Center for Global Discovery and Conservation Science efforts led by Greg Asner in the Pacific, a clearer picture of the overall ocean dynamics and health will begin to come into full view.



We expect that this new partnership will be a huge benefit to all Earth scientists seeking a clearer and more concise view of the 'state of the planet.'"

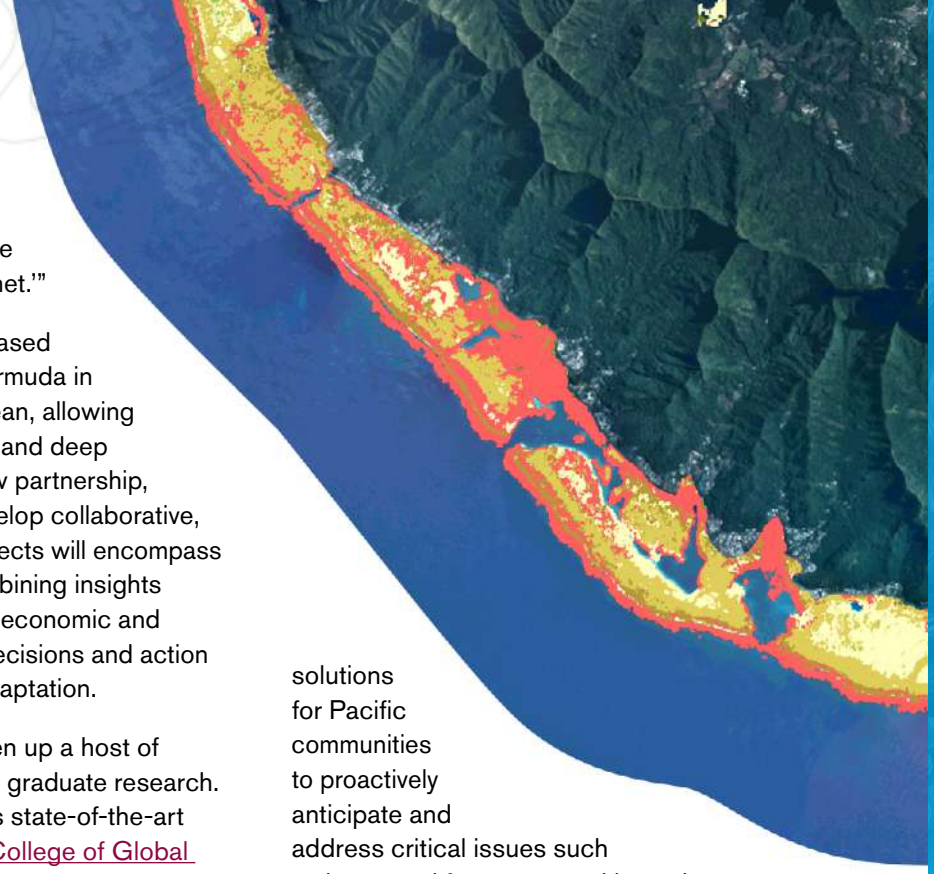
BIOS' deep-ocean observatory is based in St. George's on the islands of Bermuda in the middle of the North Atlantic Ocean, allowing researchers to study inland, coastal and deep ocean ecosystems. Through this new partnership, ASU researchers will be able to develop collaborative, pan-disciplinary projects. These projects will encompass a wide range of oceans issues, combining insights into physical, biogeochemical, socioeconomic and sociocultural knowledge to inform decisions and action on climate change mitigation and adaptation.

Additionally, the partnership will open up a host of opportunities for undergraduate and graduate research. Students will gain access to BIOS's state-of-the-art facilities and programs, equipping College of Global Futures students with more tools to meet the global challenges of today and tomorrow.

Helping islands weather climate change

The National Oceanic and Atmospheric Administration has announced a five-year, $6.36 million research grant that will launch the Pacific Regional Integrated Sciences and Assessments (Pacific RISA) program as a research center within the Global Futures Laboratory. This partnership with ASU is the next step in an ongoing effort of the Pacific RISA initiative to support communities in the Pacific region in becoming more resilient to the effects of climate change.

The team will expand their research, advocacy and action from their home base on the island of O'ahu, Hawai'i, leveraging support from the East-West Center, the University of Hawai'i Water Resources Research Center and various other stakeholders as well as ASU, to address the most pressing regional and community-specific climate challenges. They will develop practical solutions for Pacific communities to proactively anticipate and address critical issues such as increased frequency and intensity of climate-related extreme events.



The oceans play a significant role in maintaining the health of our planet. ASU's new oceans partnerships open the door for new research collaborations, innovative ideas and direct action. ■

"Providing science-based decision support for solving problems facing communities around the globe lies at the core of shaping a habitable future."

— Peter Schlosser, vice president and vice provost of Global Futures at ASU

Allen Coral Atlas mapping

The Allen Coral Atlas is a game-changing conservation tool powered by ASU.

Pulling carbon out of the air

Imagine a technology that could not only help us slow carbon emissions, but actually reverse them. That is the goal behind MechanicalTrees™, developed by scientists at ASU's Center for Negative Carbon Emissions (CNCE) and commercialized by Carbon Collect. Each MechanicalTree does the work of 1,000 living trees in removing carbon dioxide from the air. The first MechanicalTree is on track to be unveiled at ASU's Tempe campus in early 2022.

Each MechanicalTree contains 150 disks stacked in a column that stands around 30 feet high. As wind passes through the open column, the disks bind CO_2 to their surfaces, just like leaves on a tree. After about an hour, the column collapses into its base. Once sealed inside the base, the collected CO_2 is converted into purified, compacted carbon that can be sequestered in the ground or commercialized for use in industries like agriculture. ■

Klaus Lackner, director of the CNCE, was named one of America's Greatest Disruptors by Newsweek magazine in December 2021.

#1 for sustainability in North America

— Sierra Club, 2021

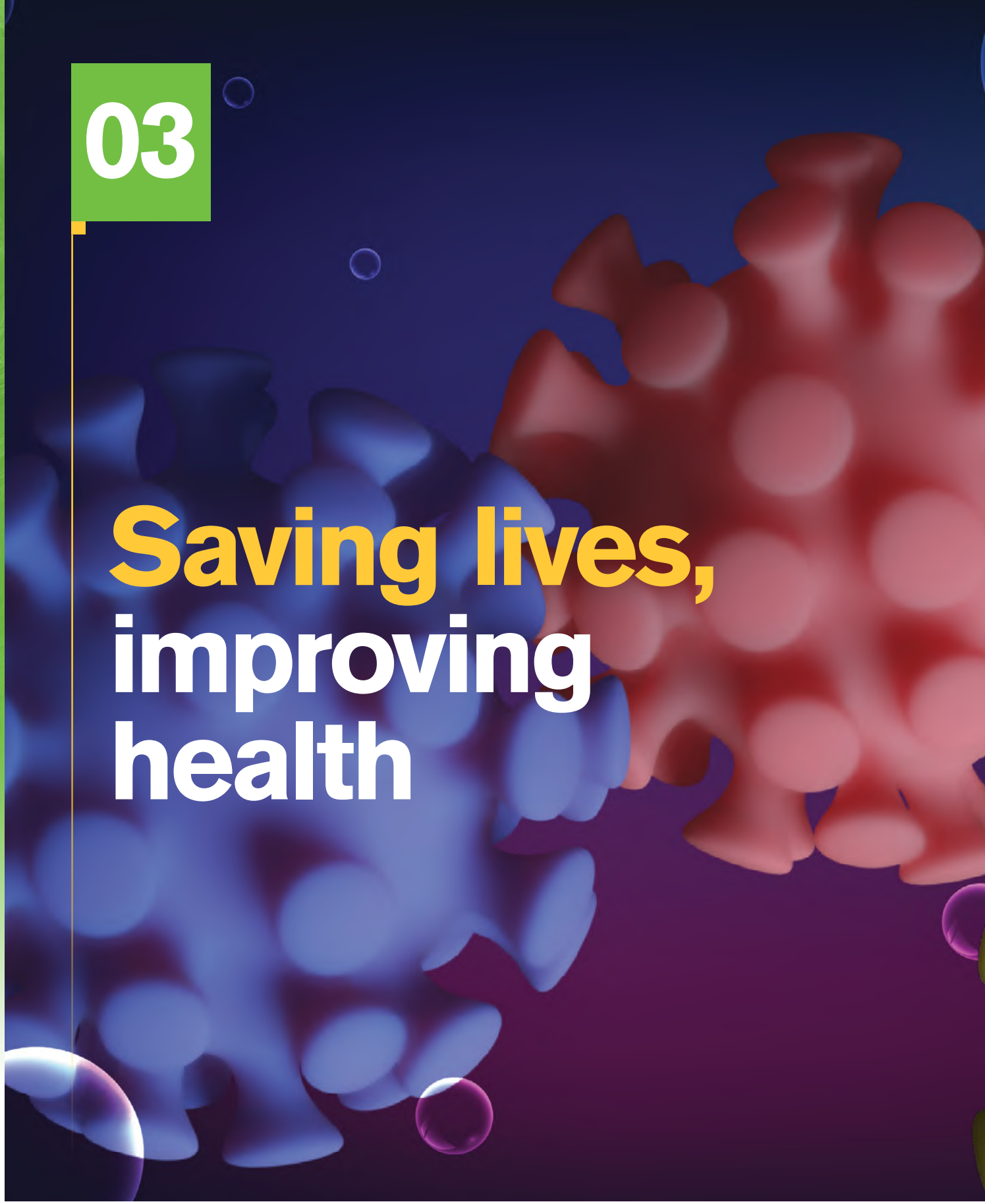
Your generosity accelerates the transition to a carbon negative economy. Donate to the CNCE.

The world's first and only comprehensive laboratory focused on our global future

In April 2022, ASU will formally open the doors to a new space built for the future that honors the land and people of its past. On track to meet LEED Platinum standards, the Interdisciplinary Science and Technology Building 7 embodies the philosophy behind the Julie Ann Wrigley Global Futures Laboratory. Every level of this new structure will equip and inspire students, faculty, staff and guests to explore and address the critical issues related to the future of our planet.

What's inside?

- Home to the Global Futures Laboratory and the Institute of Human Origins.
- 70,000 square feet of laboratory space, as well as classrooms, offices and collaboration space.
- Capacity to capture 100% of rainfall to recharge the aquifer and water a diverse selection of native plants.
- Integration of ideas and technologies from the site's history, including the continued activation of a rebuilt Indigenous canal.
- Exterior skin custom-designed to optimize shade and passively cool the building from Arizona's hot climate. ■



03

Saving lives, improving health

Uniting with the community to combat COVID-19

ASU has processed over 1 million COVID-19 tests and helped administer nearly 2 million vaccines, partnering with the state to protect Arizonans.

Arizona State University completed its 1 millionth COVID-19 test in October 2021, a milestone that commemorates the university's massive effort to marshal all its resources and respond to the pandemic statewide.

ASU developed enough tests to administer to 1 in 7 Arizonans and invented the first saliva-based test publicly available in the U.S.

Prior to the saliva test, the only option available in the early months of the pandemic was an expensive and uncomfortable nasopharyngeal swab. This was risky for health care workers to collect, as they had to be close to an unmasked, potentially ill person — and sometimes the swab would trigger a sneeze.

"There was a need, and then ASU and the Biodesign Institute stepped up," says Vel Murugan, associate director of research and an associate research professor at the Biodesign Virginia G. Piper Center for Personalized Diagnostics. "And we did it. We saved a lot of lives for sure."

Part of the team's impact came early on in the crisis. Commercial clinical labs were slow to provide results. Test results weren't getting back to people for seven to 10 days. ASU consistently delivers results within 48 hours of receiving samples, and usually between 24–30 hours.

"We were getting answers to people when it mattered for them to know that they were infected and know that they had to get out of circulation. That's been a point of pride for us. We've maintained that sort of rapid turnaround the whole time," says Joshua LaBaer, executive director of the Biodesign Institute.

Sixty-four percent of ASU's tests were given to the public, many at the 71 public testing sites around Arizona that were designed by ASU and administered by the Arizona Department of Health Services.

When vaccines became available, the team applied their experience to setting up the first state-run,

In 2021, the ASU Biodesign Clinical Testing Laboratory received accreditation from the College of American Pathologists, the nation's largest organization of board-certified pathologists.

CAP ACCREDITED
COLLEGE of AMERICAN PATHOLOGISTS

Your generosity can help save lives and improve human health.

Donate to the Biodesign Institute.

asufoundation.org/biodesign

24-hour vaccination site in the country within five days. ASU partnered with the state to administer over 1.7 million vaccine doses.

Their efforts were recognized by President Joe Biden during a virtual tour of the State Farm Stadium vaccination site.

Phoenix Mayor Kate Gallego said at the time, "We really are leaders for the entire country."

Find a COVID-19 saliva test in Arizona.

Model behavior

Few situations are as uncertain as a global pandemic caused by a completely unknown virus. As COVID-19 surged in Arizona and throughout the country, so did people's questions. How does the virus spread? What is the best way to protect ourselves? Do we need booster shots, and when?

Public policymakers, health care leaders and corporate executives need concrete data to formulate plans for reopening strategies and safety policies.

Filling the information void is ASU's COVID-19 modeling task force, Modeling Emerging Threats for Arizona (METAz). The experts in epidemiological modeling have emerged as leading providers of data about the coronavirus and its rapid spread in the state, helping government agencies such as the Arizona Department of Health Services, businesses and individuals make informed decisions on how best to protect human health and well-being.

"One of the big things we focused on with our models was hospital capacity," says Heather Ross, an ASU clinical associate professor and METAz team member. "We were able to let public officials and health care officials know what they would need in terms of COVID beds and nurses to care for patients. Hospitals were then able to make adjustments, such as canceling elective surgeries. We were able to make sure that everyone who needed an ICU bed in the state of Arizona was able to get an ICU bed."

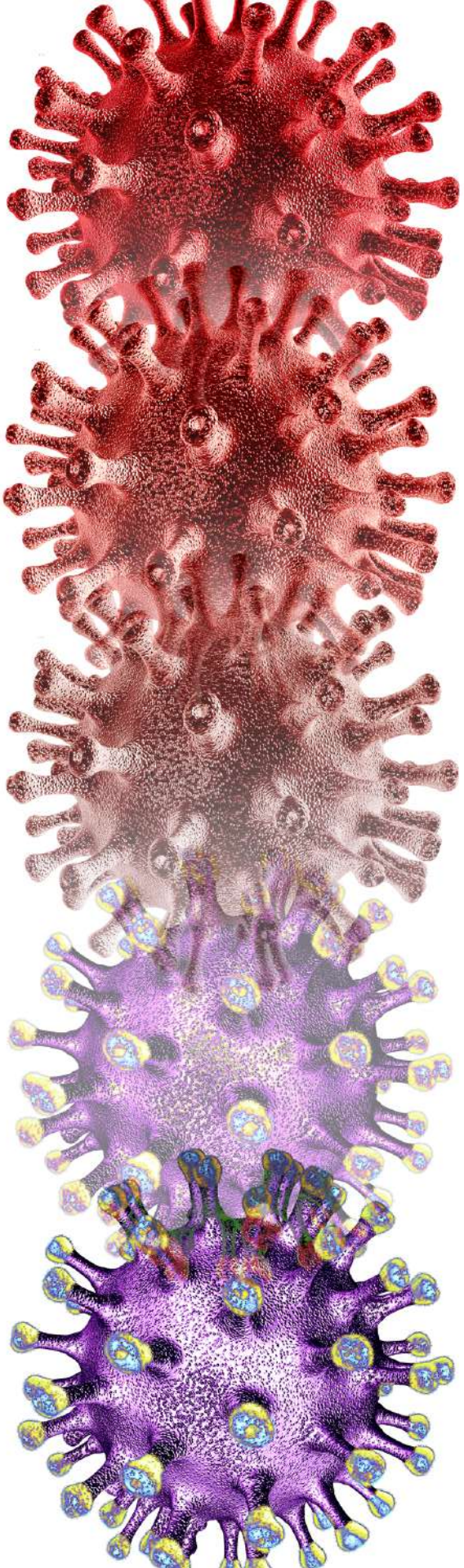
Tracking variants

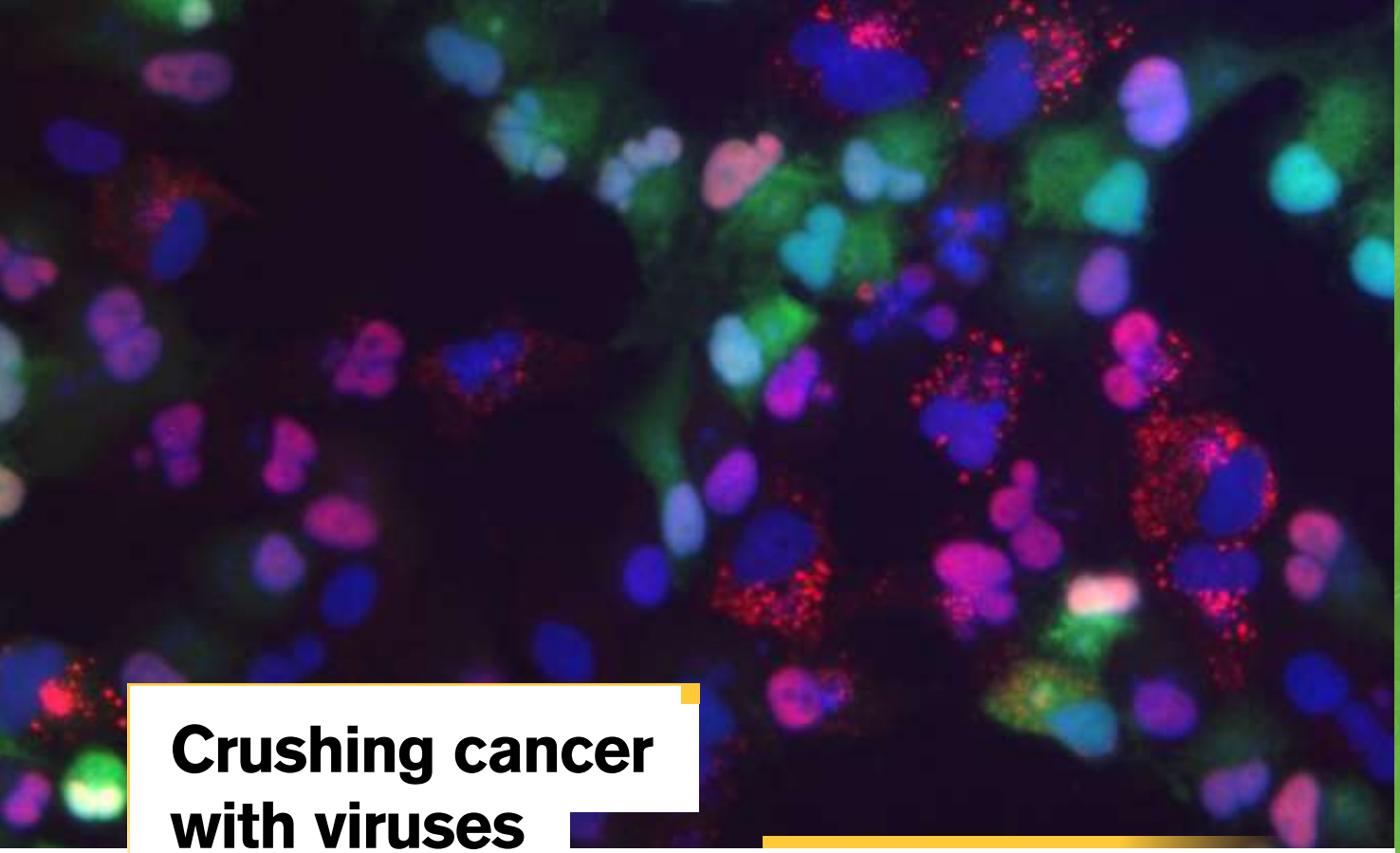
When the COVID-19 pandemic struck in the U.S., ASU launched aggressive efforts to better understand and prevent its spread. ASU researchers began amassing data and sequenced the genomes of the first coronavirus cases in Arizona.

A growing repository of samples testing positive for the virus gave researchers the raw material for the next step — identifying variants and exploring their prevalence and distribution.

In the race against variants, speed is crucial. Mutations are often cumulative in their effects, and this is the essence of the threat that they pose. One variant may increase a virus's resistance to vaccines by 5%, but combined with another mutation, this can rise to 10%, then 20% and so on. The longer the virus circulates among unvaccinated people, the greater the risk of new and potentially dangerous variants emerging.

The university's dual ability to test saliva and rapidly sequence positive samples has made the Biodesign Institute a national leader in the battle against COVID-19. Samples are sequenced at an accelerated pace, because the positive tests only need to be sent upstairs to the sequencing lab, with rapid turnaround times for data processing. By the time other institutions have shipped out positive COVID-19 tests for further analysis, the sequencing has already been completed in-house at ASU. ■





Crushing cancer with viruses

The image shows antiviral granules (seen in red) sprayed into the cytoplasm by the protein DHX9. These granules act to inhibit replication of the myxoma virus, which is being explored as a therapy to treat cancer.

With the world still in the grip of a devastating pandemic, it's hard to imagine viruses as something other than hostile enemies to be vanquished.

But some viruses have a remarkable ability to target and destroy cancer cells, while leaving healthy cells untouched. Researchers are working to harness these "oncolytic" viruses to improve human health.

"The field of oncolytic virotherapy today is advancing rapidly as clinical trial data accumulates and regulatory approvals continue to accrue," says Grant McFadden, director of the Biodesign Center for Immunotherapy, Vaccines and Virotherapy at Arizona State University.

McFadden and Masmudur Rahman, an associate research professor in the center, recently published a review article in the journal Cancers that describes the latest research in the field and which approaches hold the greatest promise.

McFadden, a pioneer in the field of oncolytic viruses, studies myxoma virus, a member of the pox family. Myxoma is almost 100% lethal to European rabbits, but harmless to humans and other non-rabbit species. However, when myxoma encounters human cancer cells, it will attack and kill them.

Viruses are the most abundant biological entities on earth, easily outnumbering all other life forms combined, though they inhabit a shadowy world somewhere between living and nonliving matter.

Viruses infect every form of cellular life, including animals, plants, bacteria and fungi. While they are notorious for causing serious illness, they also play vital roles in evolving ecosystems — roles that scientists are only beginning to appreciate.

Viruses can roughly be broken down into "specialists," which are selective in the particular organisms they infect, and "generalists," which are more promiscuous about the species they target and invade. Oncolytic

viruses lean toward the specialist category. While showing little to no danger for normal mammalian cells, they can be fierce assassins of the malignant cells associated with cancer.

Cancer remains a leading killer globally. It is expected to cause 1.9 million cases and 608,570 deaths in 2021 in the U.S. alone, according to the American Cancer Society. The discovery of cancer-killing viruses has opened a new door to cancer therapies that may fulfill the elusive goal of eradicating cancer while leaving healthy cells unharmed.

Researchers in the field are exploring a variety of advances, from how to carry the viruses to the cancerous tumors, to engineering them to trigger a stronger anti-tumor immune response, to helping them evade the cancer cells' defenses.

In June 2021, Masmudur and McFadden published a study in the Journal of Virology that identified a component in some cancers that are known for resisting treatment. The component, called RNA helicase A/DHX9, reduces the effectiveness of myxoma virus against cancer cells. By identifying the culprit, the researchers have opened the door to developing new therapies that could neutralize its antiviral properties and improve myxoma's cancer-fighting potential.

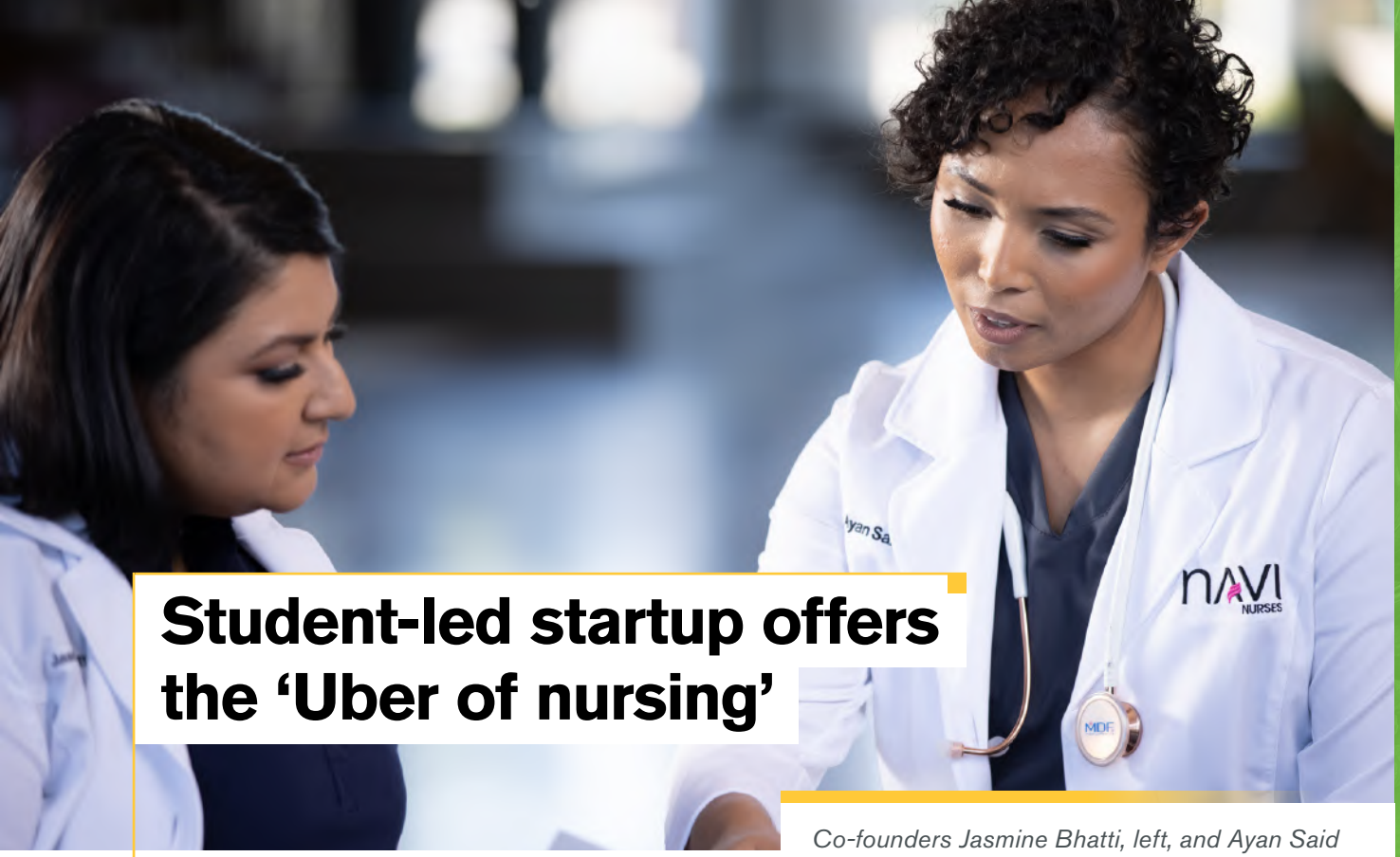
Grant McFadden's lab is part of the Biodesign Center for Immunotherapy, Vaccines and Virotherapy, which is examining how viruses can target and destroy cancer cells.

$1 billion

ASU startup companies working with Skysong Innovations, ASU's exclusive intellectual property management company, reached $1 billion in external funding in 2021.

"We are trying to improve myxoma virus' ability for infection, replication and killing different types of human cancer cells," Masmudur says. "We are doing it by identifying and targeting the cellular proteins that restrict myxoma virus replication in human cancer cells."

McFadden, who has spent decades researching the natural cancer-fighting properties of the myxoma virus, co-founded OncoMyx Therapeutics in 2018. Since then, the company has further developed myxoma as a platform to deliver multiple cancer-killing payloads in one immunotherapy. In December 2021, OncoMyx received $50 million in series B financing to advance its lead therapeutic candidate into clinical trials. ■



Co-founders Jasmine Bhatti, left, and Ayan Said

Student-led startup offers the 'Uber of nursing'

An ASU doctoral student is helping fill a critical gap in nursing care, with support from the J. Orin Edson Entrepreneurship + Innovation Institute.

As a registered nurse, Jasmine Bhatti knows that patients leaving the hospital may still have a long road to full recovery. For people who don't have a network of family and friends to assist them after a hospitalization or surgery, being discharged from the hospital can be a risky time as they struggle with everything from understanding their medical condition to accessing health resources they need to recover.

Bhatti had an idea that could help — a marketplace that connects nurses to patients and families who need medical guidance and support after a hospital stay or outpatient surgery. But with a lack of business experience and an intense schedule as a nurse caring for COVID-19 patients and as a PhD student at Arizona State University, Bhatti needed some help to get her company, Navi Concierge Nurses, off the ground.

Would-be entrepreneurs can face a variety of obstacles, from not being plugged into valuable networks for mentorship and support to a lack of access to capital. Bhatti found the support she needed through the J. Orin Edson Entrepreneurship + Innovation Institute, officially established in 2020 with a generous gift from the late J. Orin Edson. He had been an ASU benefactor with his wife, Charlene, since 2005.

As a PhD student, Bhatti taught sections of ASU 101 for students in the Edson College of Nursing and Health Innovation, which introduced her to the Health Entrepreneurship Accelerator Lab (HEALab). The accelerator provides resources for innovators and entrepreneurs seeking to take health-related business ventures to market.

HEALab is an initiative supported by the Edson Entrepreneurship + Innovation Institute, the Edson College of Nursing and Health Innovation, the College of Health Solutions and the New College of Interdisciplinary Arts and Sciences. In their ASU 101 classes, first-year nursing and health innovation students receive a semester-long assignment to develop an innovative solution to a particular health problem. The HEALab provides innovation and ideation training, with some students receiving startup funding.

"That's over 600 nursing students, health innovation students, community health students and integrated health students every fall," says Rick Hall, senior director and clinical professor of health innovation in the Edson College.

When Bhatti brought her students to the HEALab, the lectures sparked something in her. "I keep this book of things I want to change in health care," Bhatti says. So, she asked Hall for his opinions. When he heard her ideas, he encouraged Bhatti to pursue Navi Nurses, which the founders liken to an Uber that families and individuals can reach out to for professional, on-demand nursing care.

"We meet people exactly where they're at in their health care journey. We fill the gaps and provide care," allowing patients and families to make the best health care decisions, Bhatti says. "We help take away caregiver burden and help people attain the best quality of life possible."

Bhatti and co-founder Ayan Said work as nurses for their company and train nurses to work for them. Until earlier this year, they also maintained their full-time hospital nursing jobs.

In the first five months of 2021, the company hired 45 contract nurses to serve the Phoenix metro area. With additional funding from competitions and investors, the company plans to build a custom app and broaden its geographical reach.

Bhatti and Said also plan to expand their charity care program. Currently, they donate care to one person or family in need every month.

In addition to their start at the HEALab, Bhatti and Said took advantage of Venture Devils, an Edson E+I Institute program that supports founders and helps connect them to funding. In May 2020, they competed in a Demo Day and won $10,000 to help build their venture.

Edson E+I's Venture Devils and Venture Devils+ programs support more than 700 teams.

"Building a business can feel daunting," Said says, "but one of the biggest lessons we've learned is that it's so important to surround yourself with the right people. Galvanizing others with a single powerful vision is how you truly make an impact. Everything else, you pick up along the way." ■

Building a healthier future

Cementing a partnership to transform health care

ASU's new Health Futures Center, home of the Mayo Clinic and ASU Alliance for Health Care, is the latest development in the nearly two-decades-long relationship between the nation's most innovative university and the recognized world leader in patient care, medical education and research. The 150,000-square-foot facility is adjacent to Mayo Clinic's Phoenix campus.

Health Futures Center:
A virtual tour

Take a look inside the new Health Futures Center, where researchers from ASU and Mayo Clinic collaborate, and where students and practitioners train in leading-edge facilities.

What's inside?

- Headquarters for the MedTech Accelerator, which helps early-stage medical device and health care technology companies accelerate go-to-market and investment possibilities.
- Wet and dry labs, a movement lab with cardio and strength research capabilities, a demonstration kitchen and a 300-person auditorium.
- Simulation lab that allows ASU nursing students and current practitioners to use cutting-edge technology and real-life environments as part of their training.

A hub for health in the heart of Phoenix

Located near ASU's Downtown Phoenix Campus, 850 PBC advances interdisciplinary biomedical research and encourages growth of the private sector in bioscience and health technology. The LEED Gold certified facility serves as the innovation and congregation hub of the Phoenix Biomedical Campus, a 30-acre urban medical and bioscience development that will eventually include seven buildings.

What's inside?

- ASU units, including the College of Health Solutions and the Edson College of Nursing and Health Innovation.
- Office, event and coworking spaces supporting The Health Entrepreneurship Accelerator Lab (HEALab), which provides resources and support for innovators looking to bring health-related business ventures to market.
- Private companies, including three spinout companies based on technology developed at ASU's Biodesign Institute. ■


850 NORTH
FIFTH STREET

04

Advancing technology for a positive future

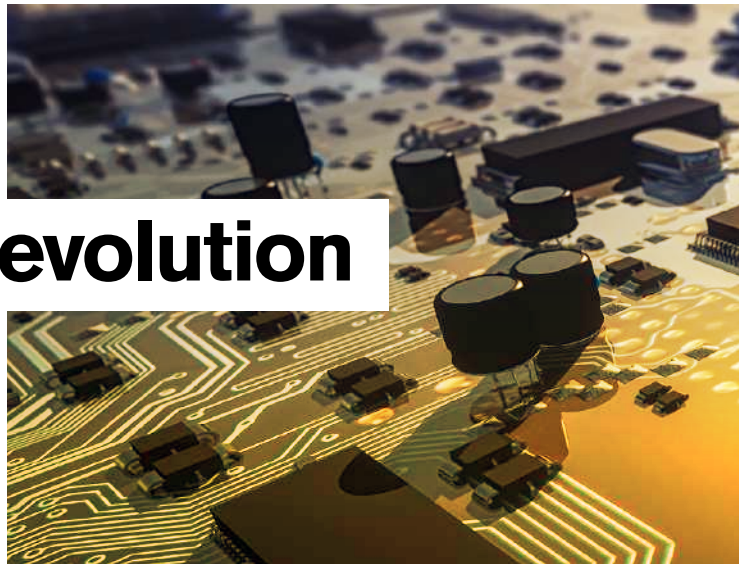
Top 10
for patents

#10 nationally and #11 worldwide for U.S. patents issued to universities

U.S. National Academy of Inventors and the Intellectual Property Owners Association, 2021

Fueling a semiconductor revolution

ASU is helping to make Arizona the perfect hub for a growing semiconductor device industry.



The field of microelectronics plays a macro-sized role in our lives. It's responsible for the tiny brains — microchips — that power most electronic things these days: familiar technology like smartphones and TVs, important medical equipment from hearing aids to MRI scanners, and even everyday appliances like microwave ovens and thermostats.

Our dependence on microchips is now underscored by the shortage that's stalling production of cars and cell phones. For supply and security reasons, there's growing interest in making more semiconductors and microchips in the U.S.

With its cutting-edge facilities, strategic partnerships, educational programming and research capability, Arizona State University is helping make Arizona the perfect hub for this growing industry.

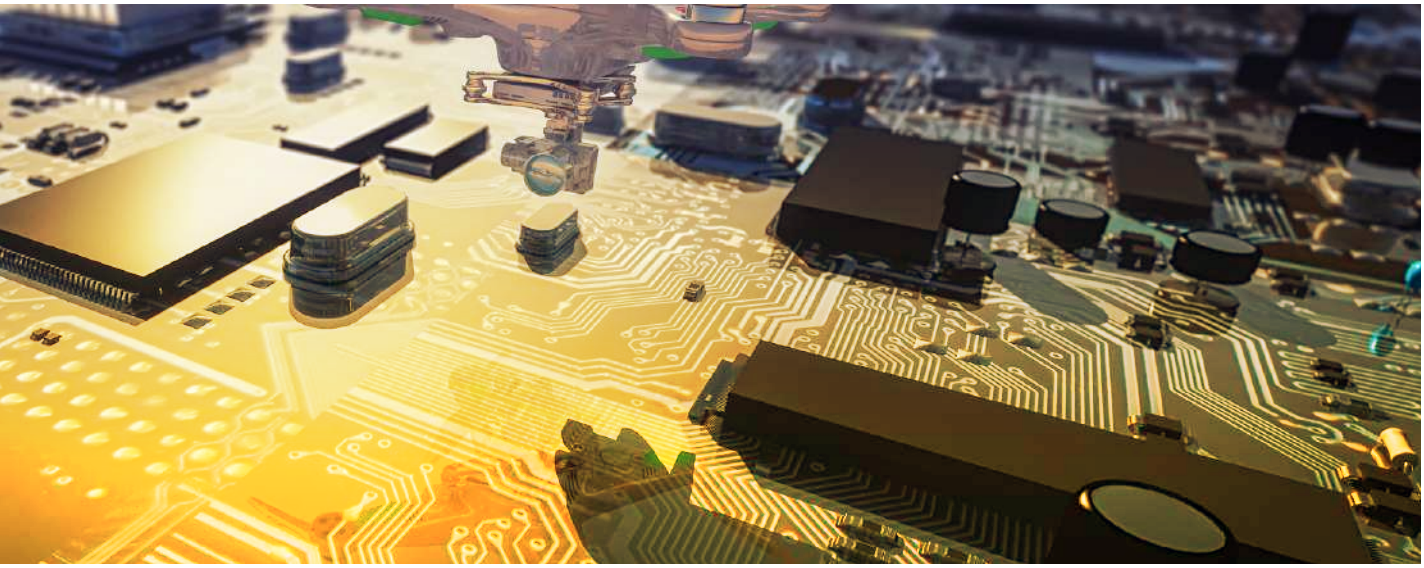
Read more about how ASU is building Arizona's semiconductor ecosystem in "Silicon in the Valley."

What's the difference between microelectronics, semiconductors and microchips?

Basically, semiconductors are used to make microchips, microchips are physical objects you can hold in the palm of your hand, and microelectronics refers to the field or industry as a whole.

Semiconductors are a type of material with the traits of both conductors, like aluminum, and insulators, like glass. A common semiconductor used in electronics is silicon. Semiconductor materials are essential to all modern electrical devices, which are often called "semiconductor devices."

Semiconductors are layered to create circuits, and circuits become microchips. Chips can range from the size of a dust mite to the size of an iPad, but most of the microchips found in everyday computers and smartphones range from the size of a fingernail to a postage stamp.



Why is there a microchip shortage right now?

Manufacturers from tech, auto and other industries expected that their sales would go down during the COVID-19 pandemic, so they ordered fewer chips. However, pandemic optimism and vaccine availability in summer 2021 led to more consumer spending. Manufacturers suddenly had more demand than supply for microchip products.

Now, fabrication plants, or fabs, are being flooded with additional requests as many industries try to order more chips at once.

"It's hard to increase the supply rapidly because the chip fabrication process takes months," says Zachary Holman, an associate professor in ASU's School of Electrical, Computer and Energy Engineering. "The fabs themselves are really complex and expensive. From the start of construction to a fab being operational is typically three-plus years."

Currently, only about 12% of global chip manufacturing happens in the U.S. Building additional fabs here would help prevent future chip shortages by adding to the world's overall fabrication capability. If U.S. fabs prioritize orders from U.S. consumers, that could help protect our domestic supply chain.

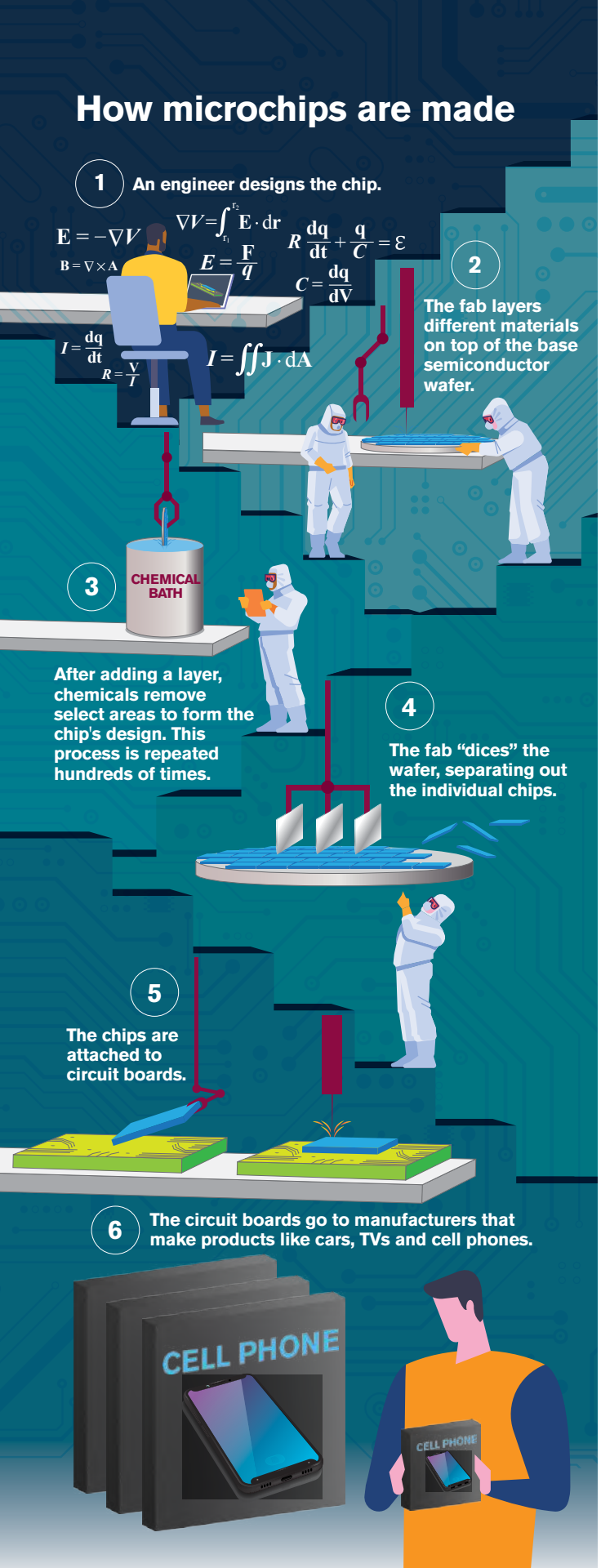
What are the national security issues to consider?

The U.S. Department of Defense's computer systems, communications systems and transportation systems all rely on microelectronic devices to function properly.

These devices are integral not only to military operations, but also critical sectors like health care and the economy. If any of those were compromised, the consequences would have an impact on national security.

In a recent report, the National Security Commission on Artificial Intelligence noted the need to develop a resilient microchip and semiconductor supply chain in the U.S. in order to stay ahead in the geopolitical technology arena.

"Increasing the design and fabrication of these technologies in the U.S. would address a major national security vulnerability — that an adversarial nation could tamper with the technology at some point in the supply chain," says Nadya Bliss, executive director of ASU's Global Security Initiative.



How is ASU helping Arizona lead the U.S. microelectronics industry?

An educated workforce is key for Arizona to become a home for microelectronics manufacturing. While ASU has been producing top-notch engineering graduates for 65 years, the Ira A. Fulton Schools of Engineering is now investing in a talent pipeline specifically for microelectronics with the creation of its new School of Manufacturing Systems and Networks.

"With the new fabrication facilities coming into the Valley from Intel and Taiwan Semiconductor Manufacturing Corp., we're expecting over 10,000 new jobs," says Kevin Reinhart, director of research project management at ASU's Knowledge Enterprise.

Students have opportunities to gain the critical hands-on experience that employers want through ASU facilities like the Advanced Electronics and Photonics facility, ASU NanoFab and the Eyring Materials Center. Researchers and industry partners can also access the specialized equipment and cleanroom facilities they need to develop new materials, methods and designs for microelectronics at industry scale.

Is your company interested in collaborating with ASU?

Contact our Business Concierge to create a customized partnership.

corporate.asu.edu

In addition, ASU will use funds from Arizona's New Economy Initiative to create five Science and Technology Centers, two of which will contribute to the state's microelectronics industry — the Energy Materials and Devices Center and the Advanced Manufacturing Center.

Advanced Electronics and Photonics facility in the MacroTechnology Works building at ASU Research Park

The university aims to bring even more funding for microelectronics to Arizona. ASU played a lead role in adding support for a domestic microelectronics industry — called the CHIPS for America Act — to the 2021 National Defense Authorization Act. If funding legislation passes, ASU will propose a National Network for Microelectronics with a university-supported core facility in Arizona.

What's next for microelectronics?

Talk about the future of microchips, and you're sure to run into Moore's law. It's more of an idea than a proven scientific theory. Essentially, it says that microchips' computational power doubles (and their size halves) about every two years. It implies that microchips will hit a limit where they can't be improved on anymore.

"Moore's law has been about one knob of optimization, namely making things smaller in two dimensions. That's why, going forward, the technical innovation in microelectronics is about building in three dimensions," Holman says.

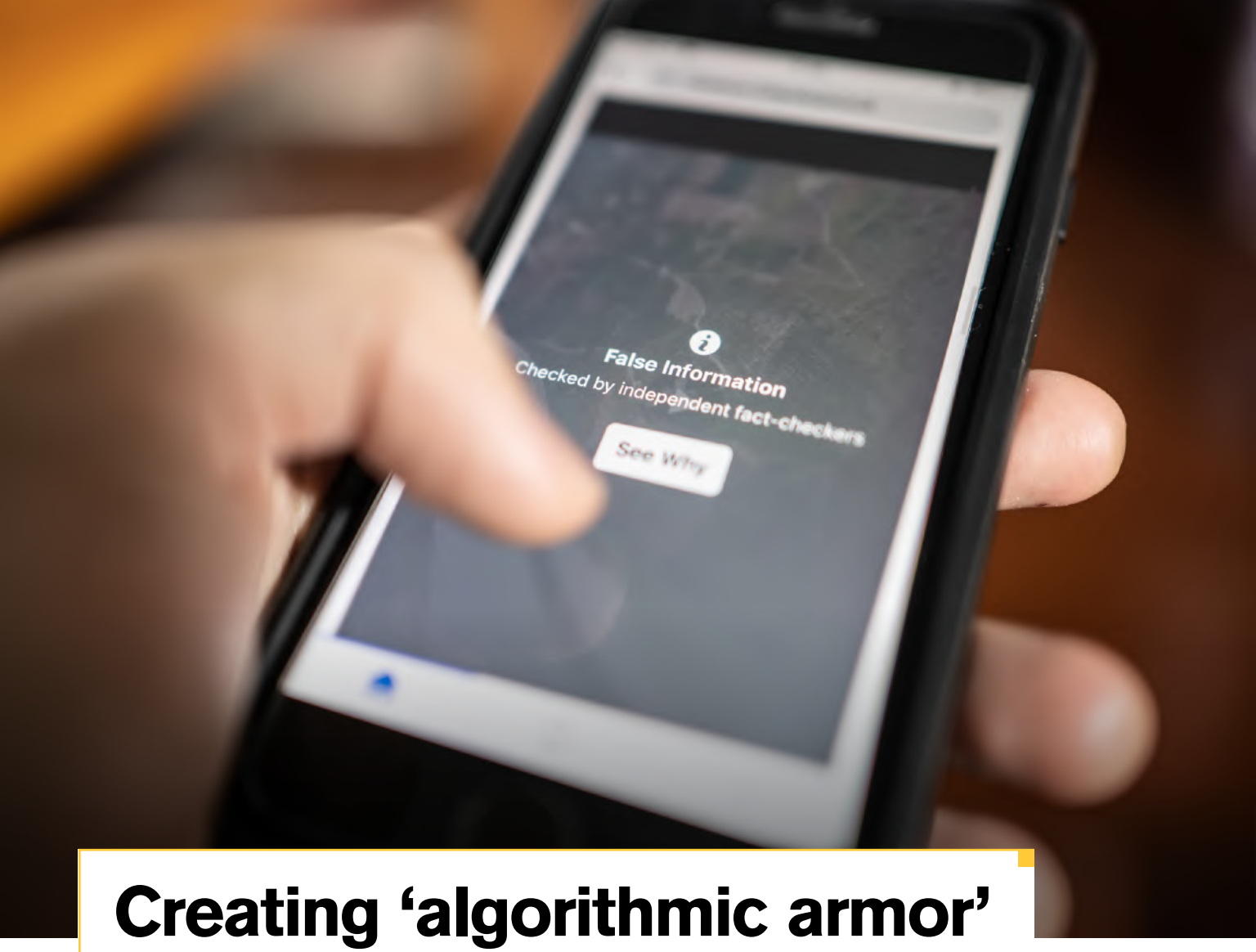
Putting different capabilities that normally exist on separate chips — such as sound, display, computation and memory — together to create an all-in-one chip is another new direction for microelectronic technology, he adds.

Additionally, microelectronics will be crucial in the shift to renewable energy. In 2020, only 12.6% of our national energy consumption came from renewable sources.

"How do we get closer to a hundred percent? Well, you need to have a lot more information about where electricity is being generated, where it's being consumed and stored, and when," Holman says.

Electronics that can share information across the grid will allow us to draw from many renewable sources and know how much is available from a source at any given time.

With around 300 days of solar-charging sunshine every year, coupled with its microelectronics research, development and fabrication capabilities, Arizona is an ideal place to find the technological solutions we need for a future that is both sustainable and leading edge. ■



Creating 'algorithmic armor' to combat disinformation

Social media accelerates the spread of false information, but ASU researchers are developing technologies to fight it.

Whether they are looking for information about Capitol Hill, COVID-19 or climate change, more than 8 in 10 adults (86%) get their news from a smartphone — often turning to Facebook, Twitter or YouTube for updates, according to a recent Pew Research Service study.

Unfortunately, studies show that disinformation spreads farther and faster on social media than trustworthy news. Social platforms reward posts that get high levels of likes, clicks and shares, regardless of whether they are accurate or not.

Disinformation poses threats to both our personal and national security. False health information might lead you to try a dangerous, untested treatment. Disinformation about elections could undermine our democratic process.

Researchers with ASU's Global Security Initiative explore how disinformation influences people and shapes our social and political landscapes. In 2021, GSI launched the Center on Narrative, Disinformation and Strategic Influence. The center brings together

ASU KEDtalk:
How to defend against fake news

Scott Ruston, director of the Center on Narrative, Disinformation and Strategic Influence, shares expert tips on how to separate fact from fiction.

"We are seeing the erosion of trust happen before our eyes — trust in government, trust in science, trust in media and trust in our fellow citizens are all deteriorating. When that trust has eroded and we cannot agree on basic facts, it becomes nearly impossible to come together to address a range of concerns, including national security issues."

— Nadya Bliss, executive director of the Global Security Initiative

experts in narrative theory, computer science, social sciences, humanities, journalism and other disciplines to develop tools to combat disinformation campaigns.

Researchers in the center are working to develop innovative technologies as a disinformation "lie detector" through the Semantic Forensics (SemaFor) program, funded by the Defense Advanced Research Projects Agency. The project aims to create technologies to help detect, attribute and characterize disinformation that can threaten our national security and everyday lives.

ASU is participating in the SemaFor program as a part of an $11.9 million federal contract with Kitware Inc., an international software research and development company. The project, titled Semantic Information Defender, is aimed at producing new falsified-media detection technology. The multi-algorithm system will ingest significant amounts of media data, detect falsified media, attribute where it came from and characterize malicious disinformation.

By improving disinformation detecting algorithms, the project will make it easier to weed out pieces of disinformation and trace its creators.

How to protect yourself from disinformation

ASU researchers share the following tips for sorting good information from bad.

- **Understand how social media works.**
  Social platforms are not news outlets and they do not check posts for accuracy. They also make money based on clicks, likes and shares, regardless of whether the information is true.
- **Be wary of emotional content.**
  If you read something that makes you outraged — or gleeful — pause and check for accuracy. Disinformation campaigns aim to provoke an emotional reaction to get more shares.
- **Look for the original source.**
  Before you share a meme with startling facts or an inflammatory quote, confirm that it is true. Credible posts will include links to the original source of information. If you can't confirm, don't share.
- **Read beyond the headline.**
  The purpose of a headline is to get you to click on the link. They are often misleading. Many times, headlines are not even written by the person who wrote the story.

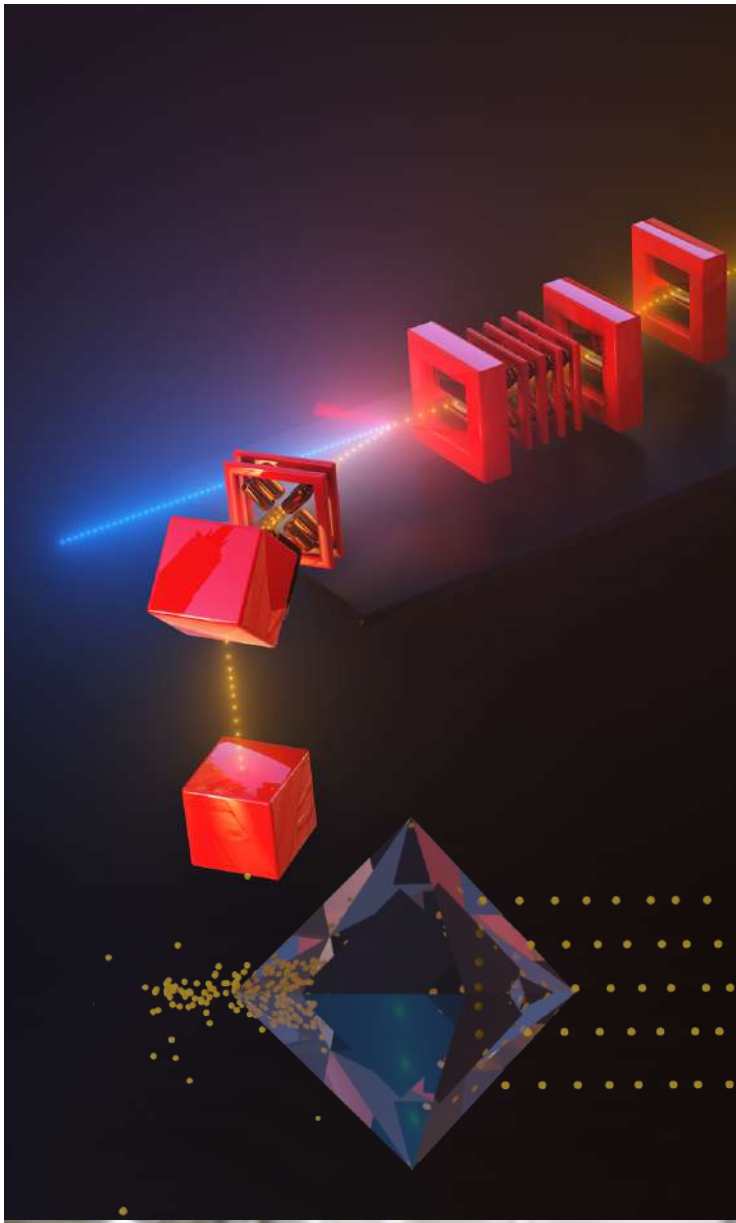
- **Examine the news sources.**
  Journalists follow a set of ethics guidelines and will name their sources, except in rare cases to protect a person's safety. Credible articles will name sources and those sources will be experts on the topic they are discussing.

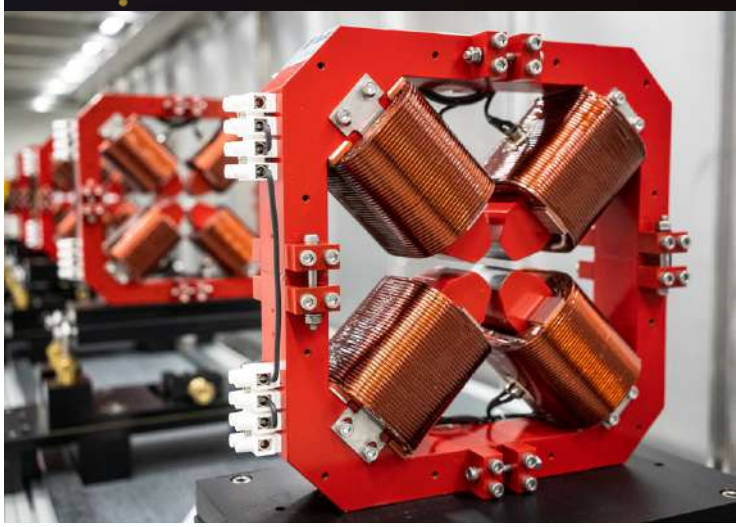
- **Get your news from a variety of places.**
  See if the information you are looking at is confirmed by other sites or publications. If only one news outlet is reporting something, that could be a red flag.

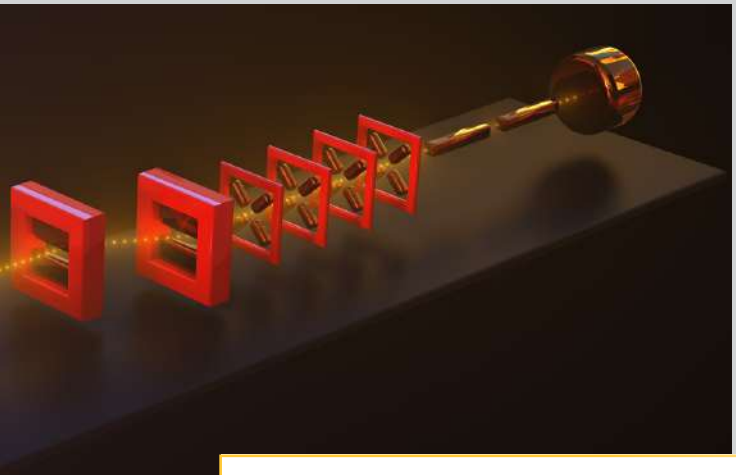
- **When you see your friends and family share disinformation, speak up.**
  Provide accurate information from credible sources, but be kind and don't insult people's intelligence. Never repeat the lie, because then you emphasize the disinformation instead of what's right. ■

Want to learn more about how to recognize and guard against disinformation?

ASU offers a free online class, **"Mediactive: How to Participate in Your Digital World,"** that teaches how to spot disinformation, how to assess claims and sources, how news media operates and more.







> **"This is a kind of eureka moment, when we turn everything on, all of these complex systems, and we see those first electrons being generated."**
>
> — William Graves, associate professor of physics and researcher at the Biodesign Center for Applied Structural Discovery

CXFEL Labs to open new horizons in research and discovery

Compact X-ray free electron laser

Look inside the CXFEL Labs and learn how the technology works.

In 2021, a team of scientists at ASU's Biodesign Institute achieved a major milestone — generating the first electrons from their innovative compact X-ray program.

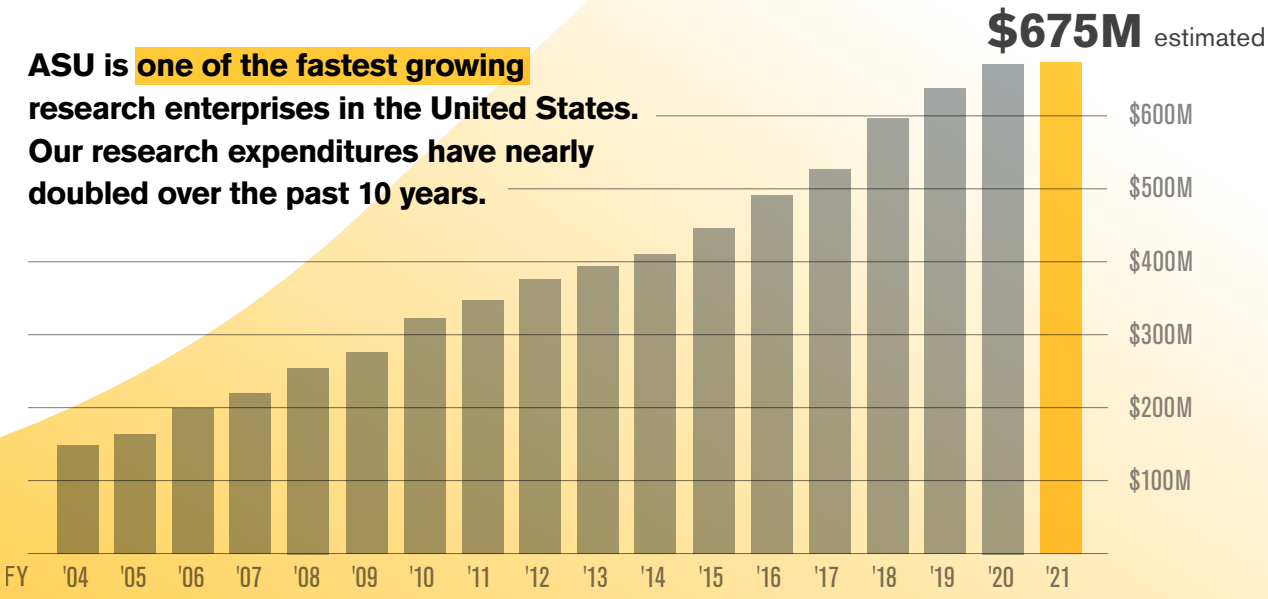
The achievement is a major operational step as the ASU scientists race to complete the project's first phase, called a compact X-ray light source (CXLS). Once fully operational, the CXLS will make ultrashort pulses of X-rays to probe into the secrets of biology, medicine and advanced materials.

For example, in biology, the CXLS acts like an ultrafast camera to see proteins and other building blocks of biology dynamically at work. A major goal of the finished CXLS device is to see reactions and relationships as they happen, which could unveil new targets for drug discovery.

The team's ultimate goal is to build the world's first compact X-ray free electron laser. The CXFEL will bring multibillion-dollar, national-laboratory-scale technology to the university, enabling researchers to pioneer novel discoveries at a fraction of the cost of established XFEL facilities. ■

05 Leading the nation in research and innovation

ASU is one of the fastest growing research enterprises in the United States. Our research expenditures have nearly doubled over the past 10 years.



Rankings by research expenditures

Source: National Science Foundation HERD Survey 2020

#1 **Transdisciplinary research**, ahead of Northwestern, the University of Pittsburgh and Johns Hopkins

#1 **Anthropology**, ahead of the University of Michigan, Harvard and Stanford

#1 **Geological and earth sciences**, ahead of MIT, Penn State and the University of Arizona

#3 **Social sciences**, ahead of Cornell, UCLA and the University of North Carolina, Chapel Hill

#4 **Business management and business administration**, ahead of Dartmouth, Northwestern and Duke

#9 **Education**, ahead of the University of Wisconsin, Madison; NYU and UCLA

ASU innovations 2021

In fiscal year 2021, ASU innovators working with Skysong Innovations* generated:

301
invention disclosures

21
new startup companies

157
U.S. patents

*Skysong Innovations is ASU's exclusive intellectual property management company.

#6 Total research expenditures among institutions without a medical school

#9 HHS-funded expenditures (including NIH), among institutions without a medical school

#10 Civil engineering, ahead of Stanford, MIT and Duke

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