



RESEARCH

YEAR IN REVIEW



ENTREPRENEURSHIP



STRATEGIC PARTNERSHIPS

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INTERNATIONAL DEVELOPMENT

INNOVATION

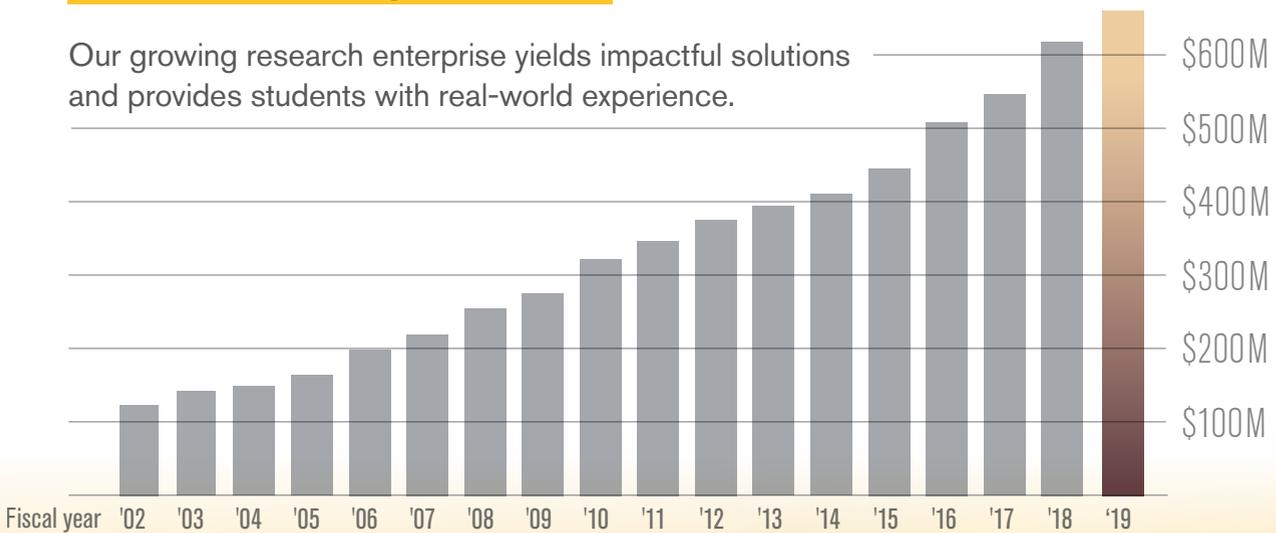
Knowledge Enterprise excellence

The ASU Knowledge Enterprise advances research, innovation, strategic partnerships, entrepreneurship and international development at the most innovative university in the nation.

ASU research expenditures

Our growing research enterprise yields impactful solutions and provides students with real-world experience.

\$635M estimated



#1 in the U.S. for innovation

ASU ahead of Stanford and MIT

— U.S. News & World Report, 5 years, 2016–2020



#10 among universities worldwide for U.S. patents issued

— National Academy of Inventors and Intellectual Property Owners Association

Rankings by research expenditures

Source: National Science Foundation HERD Survey 2018

#7

Total research expenditures
among institutions
without a medical school

#1

Geological and earth sciences,
ahead of MIT,
Texas A&M and
Virginia Tech

#1

Anthropology,
ahead of Harvard,
Stanford and
University of Michigan

#2

Transdisciplinary research,
ahead of MIT,
Johns Hopkins University
and Northwestern

#4

Social sciences,
ahead of Berkeley,
UCLA and Cornell

#5

Political science and government,
ahead of Duke, Tufts
and Penn State

#5

NASA-funded expenditures,
ahead of Stanford,
UCLA and
University of Washington

#5

Humanities,
ahead of Harvard,
Yale and Wisconsin

#7

HHS (including NIH)-funded expenditures
among universities
without a medical school,
ahead of Princeton,
Carnegie Mellon and
Georgia Tech

#8

Electrical, electronic and communications engineering,
ahead of MIT, Stanford
and Carnegie Mellon

**ASU
Innovations
FY19**

**301
inventions
disclosed**

**129
patents
secured**

**18
startup
companies
launched**

**52
licenses
and
options
executed**

Unlocking the mysteries of **DEEP SPACE**

Water from outer space could reveal oceans' origins

ASU researchers were the first to discover water in asteroid samples, casting new light on the mysterious origin of the substance on Earth. After analyzing the samples, the research team concluded that water-rich asteroids that formed in the inner solar system and struck Earth could have delivered up to half of our planet's ocean water.

Unveiling details of the oldest and coldest known white dwarf star

After a volunteer with the NASA-led Backyard Worlds: Planet 9 project discovered an ancient white dwarf star with enigmatic dust rings, an ASU research scientist joined a team that analyzed the discovery data to reveal surprising details. The oldest and coldest known white dwarf star, it's an Earth-sized remnant of a sun-like star that died, encircled by multiple rings of dust and debris. The discovery forces researchers to reconsider models of planetary systems and could help us learn about the distant future of our solar system.



An ancient oasis on Mars

NASA's Curiosity rover discovered evidence that Gale Crater, a 100-mile-wide basin on Mars, was once a water-rich environment. Rocks enriched in mineral salts suggest the existence of briny ponds that went through episodes of overflow and drying. The finding, published by scientists from Caltech and ASU, provides insights into climate fluctuations over billions of years that transformed the wetter Martian environment into the freezing desert it is today.



ASU to develop payloads for Blue Origin lunar transportation

Jeff Bezos' aerospace manufacturing company Blue Origin envisions a future where millions of people live and work in space. As part of this vision, Blue Origin is developing infrastructure for the creation of human spaceflight capabilities. ASU is partnering with Blue Origin to identify potential payloads to send to the moon. ASU would develop one or more externally funded payload experiments to be carried on Blue Origin's Blue Moon, a flexible lander capable of delivering a variety of small, medium, and large payloads to the lunar surface.

Planet, an Earth-imaging company, picks ASU as its first higher education partner

Operating the largest constellation of satellites currently in orbit, San Francisco-based Planet acquires high-resolution imagery covering Earth's entire landmass and coral reefs daily. By choosing ASU as its first institutional data partner for higher education, the company unlocked the research potential of this unprecedented stream of satellite imagery, granting ASU students and researchers access to its dataset.

Creating a better environment for a

THRIVING PLANET

Popular Science names carbon capture invention a 2019 top technology

Even if we stopped emitting all carbon dioxide today, the CO₂ already in the atmosphere will continue to warm the Earth for several decades. But efficiently pulling CO₂ out of the air may be the answer. ASU and Silicon Kingdom Holdings (SKH), based in Dublin, Ireland, announced an agreement to deploy carbon-capture technology developed at ASU's Center for Negative Carbon Emissions. The proprietary technology acts like a tree that is thousands of times more efficient at removing carbon dioxide from the air. Until now, the high cost of carbon capture has hindered the commercial application of the approach. But the technology being deployed by SKH brings the cost of capture comfortably below \$100 per metric ton at scale, the lowest in the industry. The world's first passive direct air capture technology, it could remove up to 3.8 million metric tons of CO₂ a year — equal to the emissions from 800,000 cars. Popular Science hailed the device as one of “the most important engineering innovations of 2019.”



Off-grid tech protects nation's food source

More than 80% of food on people's plates comes from family-run farms that need an affordable way to keep up with changing conditions in their soils. The solution? An ASU invention makes it possible for off-grid rural farms to access soil data from sensors without the need for electricity or costly internet connections. It's called SolarSENSE, a solar-powered, digital agricultural library with actionable videos for farmers and a wealth of plant, soil and climate information.

This ASU startup can make drinking water out of thin air



“Around the world, approximately 2.1 billion people don’t have access to clean drinking water. In the African continent alone, women and girls spend 40 billion hours collecting water each year. Everyone experiences water stress. At best case, it’s expensive and inconvenient. At worse, it is fatal!”

– **Cody Friesen**, ASU associate professor of materials science and Zero Mass Water founder

ASU startup Zero Mass Water is making great strides toward its ambitious goal of making drinking water an unlimited resource around the globe. The company has already delivered clean drinking water to people in more than 35 countries spanning six continents. Special solar panels called hydropanels, invented by Friesen, extract clean drinking water from humidity in the air.

Here are a few highlights:

- When Hurricane Maria hit Puerto Rico, the devastation left half of the island stranded without access to drinking water. Zero Mass Water partnered with NGOs to bring hydropanels to fire stations in remote areas to restore water access to first responders and their communities.
- The company installed hydropanels at the University Hospital of the West Indies’ pediatric ward in Kingston, Jamaica, providing clean water to the hospital’s youngest patients and their families through a partnership with the Caribbean Climate-Smart Accelerator.
- At the Samburu Girls Foundation, a Kenyan rescue center that helps girls achieve an education, hydropanels free the girls from the burden of collecting water and danger of waterborne diseases.

Friesen won the prestigious 2019 Lemelson-MIT Prize for invention, the largest cash prize for invention in the United States. Friesen donated his \$500,000 prize to a project with Conservation International to provide clean drinking water to the Bahía Hondita community in Colombia.

“Cody Friesen embodies what it means to be an impact inventor,” said Carol Dahl, executive director of the Lemelson Foundation. “His inventions are truly improving lives, take into account environmental considerations, and have become the basis for companies that impact millions of people around the world each year.”

Advancing the science that reveals what moves us

ASU and adidas teamed up to launch the adidas–Arizona State University Center for Engagement Science, a multidisciplinary center focused on creating a systematic approach to understanding the cognitive, emotional and physical processes that drive people toward (or away from) objects, experiences and stories.

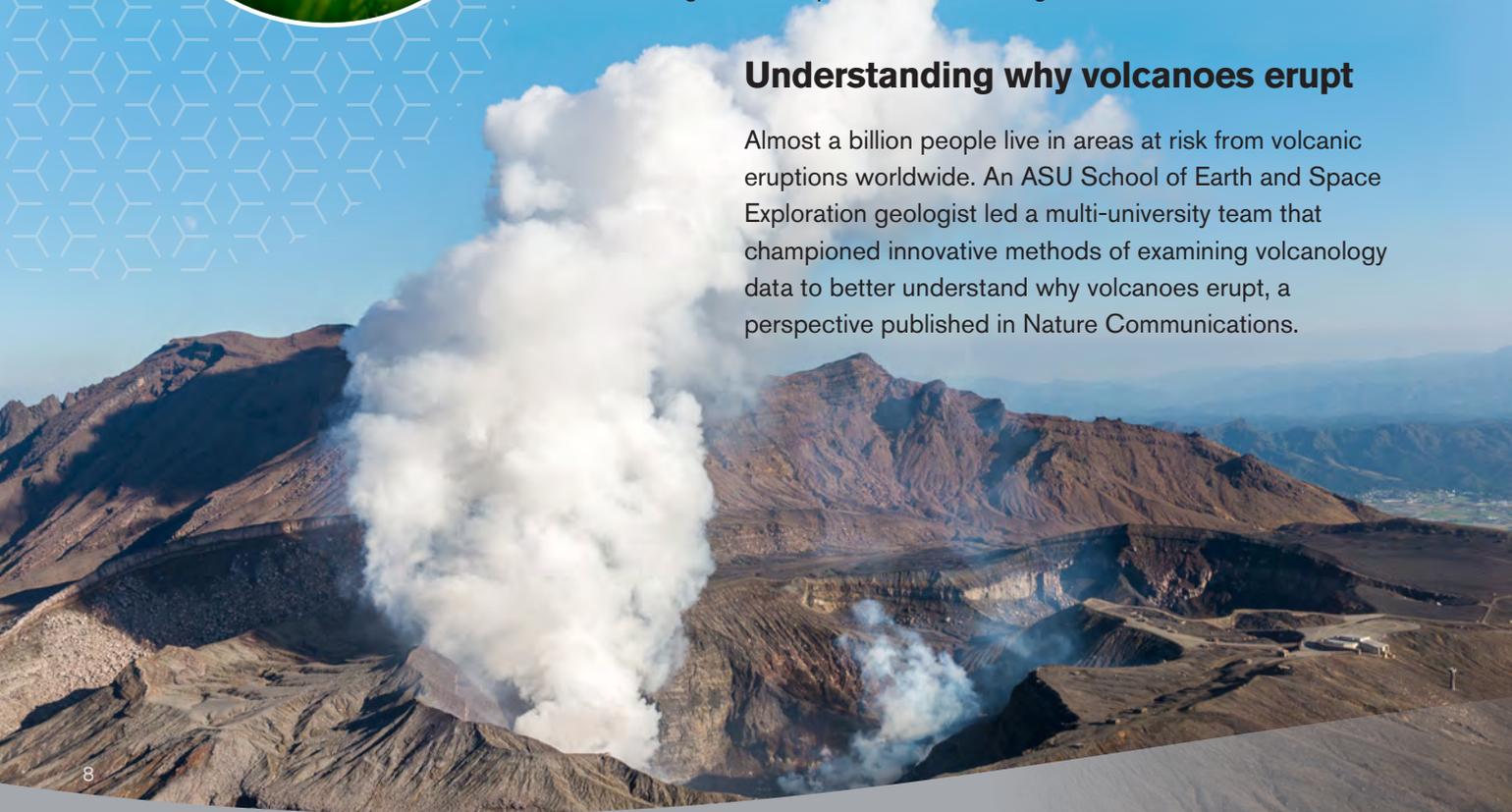


Launching the one-of-a-kind Global KAITEKI Center

KAITEKI is a Japanese word for “the sustainable well-being of people, society and planet Earth.” The concept is fundamental to the identity of the Mitsubishi Chemical Holdings Corporation and The KAITEKI Institute, MCHC’s think tank and research institute. The concept aligns seamlessly with the goals of ASU’s Global Futures Laboratory, which seeks to shape a future in which Earth and all its inhabitants can thrive. ASU and MCHC have partnered to support research aimed at realizing the concept of KAITEKI through The Global KAITEKI Center.

Understanding why volcanoes erupt

Almost a billion people live in areas at risk from volcanic eruptions worldwide. An ASU School of Earth and Space Exploration geologist led a multi-university team that championed innovative methods of examining volcanology data to better understand why volcanoes erupt, a perspective published in Nature Communications.



Seeing the light: ASU, artist James Turrell partner on masterwork in the desert



Turrell's work at Roden Crater is "a remarkable artistic and aesthetic expression, a remarkable feat of engineering, a remarkably reflective and contemplative space in a world that seems to be very hurried. It takes you out of your normal routine and puts you into a transformational space to experience the world. This one project is one of the best examples of an interdisciplinary exploration that we have."

– **Steven Tepper**, dean of the Herberger Institute for Design and the Arts

Copyright James Turrell/Photo by Klaus Obermeyer

ASU forged a new and innovative partnership with James Turrell, an internationally acclaimed artist whose medium is light itself, to complete his Roden Crater project on the southwestern edge of the Painted Desert outside Flagstaff. For more than four decades, Turrell has sculpted the inside and outside of the natural cinder cone crater, shaping the rim to frame the sky and carving tunnels and chambers to harness celestial light to create an immersive observatory.

The crater is the magnum opus of an artist whose work has been presented at the Whitney Museum of American Art in New York, the Israel Museum in Jerusalem, the Museum of Contemporary Art in Los Angeles and the 54th Venice Biennale. On the ASU Tempe campus, one of Turrell's famed Skyspaces, called "Air Apparent," invites viewers to experience light as an almost tangible presence in a contemplative, intimate architectural environment.

A fusion of art, engineering, astronomy, architecture and neuroscience, Roden Crater is a natural fit for ASU, a pioneer in interdisciplinary exploration.

Advancing knowledge across

INTERNATIONAL BORDERS

Expanding access to education in Malawi

In Malawi, a largely agricultural country in southeastern Africa, a variety of obstacles leave more than 80,000 citizens with no access to higher education each year. Empowered by a \$10 million grant from the United States Agency for International Development, ASU is on the ground in Malawi working with local educators and universities to build out a framework that will expand access to education around the country.

Throughout the four-year project, ASU will expand access to online education and distance learning initiatives and will train educators on delivering course instruction in remote areas. The primary goal is to improve education opportunities for the country's poor and rural citizens, people with disabilities, and women and girls.

MiniMasters offer continual learning for global development

ASU awarded MiniMasters certificates in global supply chain management to more than 350 Chemonics International employees in 25 developing countries. ASU and Chemonics International, a global development company working in 75 countries, launched the certificate program to open the door to affordable, world-class continual learning opportunities for the company's nearly 5,000 employees worldwide.





Connecting with **COMMUNITIES** to drive economic development



New accelerator program empowers outstanding startup founders

SparkLabs Group, a network of accelerators and venture capital funds, launched a new accelerator program with ASU named SparkLabs Frontier-ASU. It is a hub for training, mentoring and investment funding for all participants across various schools and programs, including the Ira A. Fulton Schools of Engineering, W. P. Carey School of Business and Thunderbird School of Global Management. The program is also open to all ASU alumni. The partnership will bring ASU student and alumni companies into the SparkLabs family of more than 200 world-class startups.

ASU launches downtown Chandler makerspace

ASU launched Hub249, a 13,000-square-foot makerspace that allows community members, alongside ASU students and faculty, to prototype, create and make new products affordably. Hub 249 offers tools, equipment, design software and classes through monthly memberships. The makerspace is part of the ASU Chandler Innovation Center, a partnership with the City of Chandler.

ASU, Infosys partnership to accelerate workforce development

Infosys, a global leader in technology services and consulting, chose the Novus Innovation Corridor as its sixth U.S. hub, a move that is expected to accelerate workforce development in Arizona. Infosys also forged a partnership with InStride that will allow its employees to complete degree programs and continuing education courses through ASU.

Putting emerging technologies to work for ASU and Greater Phoenix

Major cities like Phoenix are evaluating how to become smarter. The transformation will require technologies such as artificial intelligence, machine learning, sensors and robots to solve pressing urban challenges like traffic congestion and environmental sustainability. Empowering Greater Phoenix through emerging technologies, ASU and Amazon Web Services (AWS) teamed up to open the new ASU Smart City Cloud Innovation Center, located at SkySong, The ASU Scottsdale Innovation Center.

With the computing power of the AWS cloud platform at their fingertips, local planners will be able to leverage sensors and devices to optimize traffic flow versus building a new highway. Likewise, the center will empower planners to spur economic and workforce development and solve critical challenges through machine learning, artificial intelligence and analytics available on the platform.

An advance that lays the groundwork for smart cities technology, 5G networks make it possible for potentially billions of devices — cars, street lights,

cameras and utilities, to name a few — to communicate at speeds 10 to 100 times faster than today, enabling critical real-time decisions about traffic control, energy usage and more. ASU forged a partnership with Sprint to bring 5G service to the university, contributing to increased Greater Phoenix internet connectivity. The duo will establish a “Curiosity University” that will offer an advanced degree in internet of things (IoT) development, creating research opportunities in blockchain technology and other emerging technologies.

In another strategic partnership, ASU and Cox Communications joined forces to create the Cox Connected Environments Collaboratory, to be housed at SkySong. This incubation center and convening space will engage ASU students, staff and faculty to design the next wave of IoT solutions for Greater Phoenix and beyond. Cox will deploy Cox2M, a new IoT business line for asset tracking and monitoring, and a comprehensive wired and wireless network on campus as part of ASU’s NextGen network.





Creating human **WELL-BEING** one discovery at a time

Treating cancer with viruses

OncoMyx Therapeutics, a recent biotech spinout company from ASU's Biodesign Institute, raised \$25 million in new funding to help commercialize an innovative, viral-based therapy for the treatment of cancer.

The announcement marked a major business development milestone for OncoMyx founder, researcher and Biodesign scientist Grant McFadden, a pioneer in a new field called oncolytic virotherapy, which can successfully program a virus to infect and kill cancer while leaving normal cells unharmed.



Improving autism symptoms through the gut-brain connection

Today, about 1 in every 59 children in the U.S. is diagnosed with autism, and up to 90% of them suffer from gut issues. Is there a connection between the microbes in the gut and the signals that travel to the brain? Increasing evidence suggests there is, including a small trial performed by ASU researchers that demonstrates physical and behavioral improvements in children diagnosed with autism using a revolutionary technique, microbial transplant therapy — or fecal transplants. The next step is a larger, placebo-controlled trial.

ASU startup wins Arizona Innovation Challenge

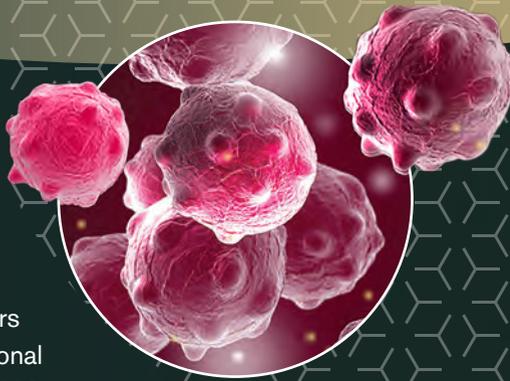
The Arizona Commerce Authority named Breezing, an ASU spinout company, as an Arizona Innovation Challenge winner. Breezing developed a wearable device that delivers precise recordings of resting metabolic rates in real time. The information helps users improve health through personalized diet and exercise plans.

A nonsurgical biopsy for breast cancer

The best breast cancer diagnostic tool now available, mammograms, can lead to unnecessary surgeries. But researchers from ASU's Biodesign Institute, Translational Genomics Research Institute (TGen) and Mayo Clinic in Arizona developed a new type of blood test for breast cancer, which could help patients and doctors avoid thousands of unnecessary surgeries and otherwise precisely monitor disease progression.

Published in the premier journal *Science Translational Medicine*, the researchers' study suggests that a test called TARDIS — TARgeted DIgital Sequencing — is as much as 100 times more sensitive than other blood-based cancer monitoring tests.

TARDIS is a "liquid biopsy" that specifically identifies and quantifies small fragments of cancer DNA circulating in the patient's bloodstream, known as circulating tumor DNA (ctDNA). By precisely measuring ctDNA, the test can detect the presence of residual cancer, a telltale sign of whether the cancer was successfully eradicated by treatment.



Rapidly diagnosing UTIs — and reducing antibiotic use

Urinary tract infections (UTIs) cause one-fourth of all bacterial infections in humans. Women, in particular, fall prey to UTIs. Global statistics suggest that 60% of women have experienced them. Diagnosing and treating a UTI is a tricky business, usually taking more than 24 hours. With no quick way to identify the bacteria, the standard treatment is an antibiotic. This is a problem since antibiotic resistance is one of the biggest threats to global health today. Researchers at ASU's Biodesign Institute, in collaboration with Mayo Clinic, are creating a new tool that will help diagnose UTIs in 90 minutes.

ASU partners with Barrow on neuroengineering

The renowned Barrow Neurological Institute has partnered with ASU on a new enterprise to survey and conquer that final frontier, the human brain. The Barrow-ASU Initiative for Innovation in Neuro-Engineering will bring together leading experts from both institutions to innovate devices, technology, therapies and research to improve brain and spinal cord function and transform the lives of patients with neurological disorders.

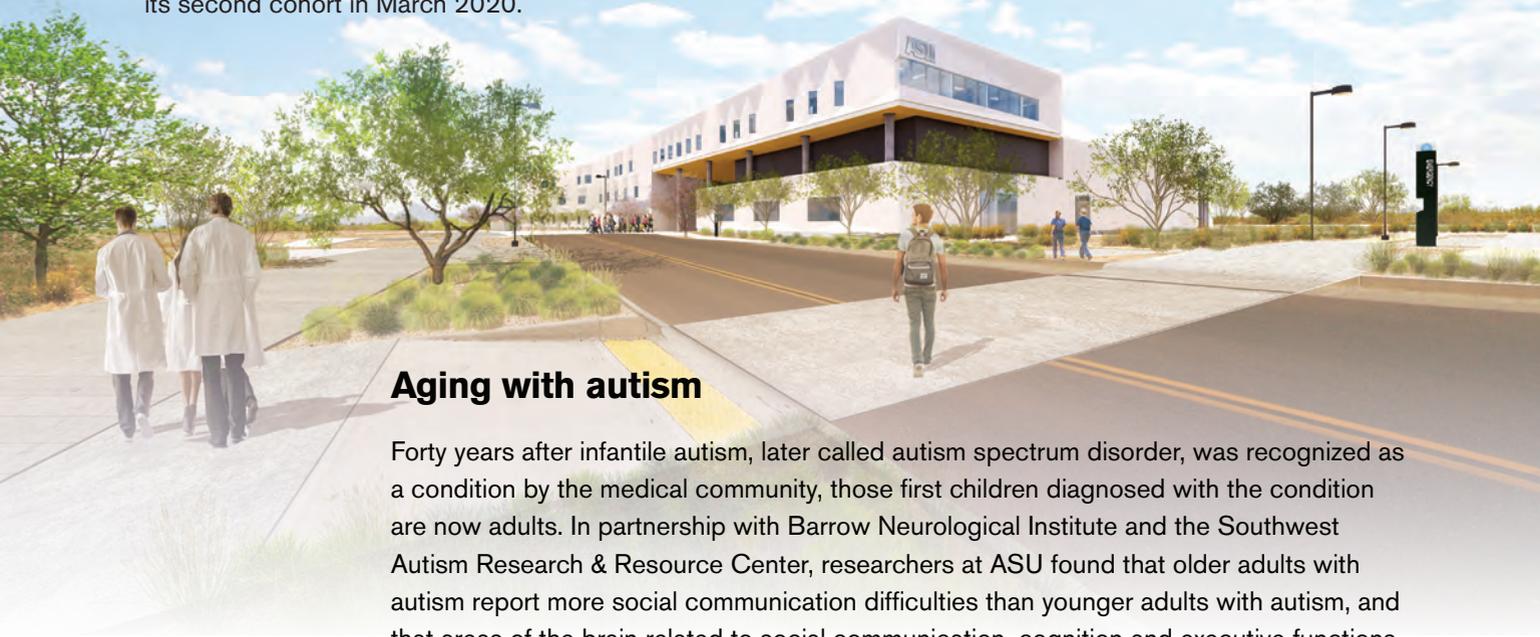


The future of health to have new home

ASU and Mayo Clinic broke ground on the new Health Futures Center, located just steps away from Mayo Clinic's north Phoenix campus. Scheduled to open in late 2020, the 150,000-square-foot building will feature biomedical engineering and informatics research labs, nursing programs, and an innovative education zone. The facility will also house the Mayo Clinic and ASU MedTech Accelerator. Launched in 2019, the accelerator has provided customized resources to six startup companies during its first cohort and is welcoming its second cohort in March 2020.

“This will be a hub of life science innovation that will not only benefit ASU students and researchers but truly the patients of the future.”

— **Gianrico Farrugia**, president and CEO of Mayo Clinic



Aging with autism

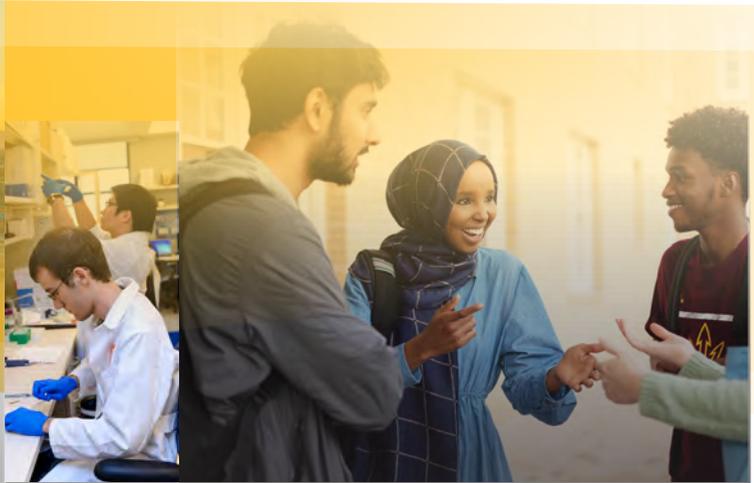
Forty years after infantile autism, later called autism spectrum disorder, was recognized as a condition by the medical community, those first children diagnosed with the condition are now adults. In partnership with Barrow Neurological Institute and the Southwest Autism Research & Resource Center, researchers at ASU found that older adults with autism report more social communication difficulties than younger adults with autism, and that areas of the brain related to social communication, cognition and executive functions thinned more quickly with age in adults with autism than in those without.

Shedding light on a risk factor for suicide

Nearly four Arizonans a day die by suicide, even more than the number who die in car accidents. It's literally a matter of life or death to know which populations to target for intervention. Researchers at ASU have shed new light on the public health crisis by identifying an at-risk population: victims of intimate partner violence. A report from ASU's Center for Violence Prevention and Community Safety revealed one in four suicides in Arizona are related to violence involving an intimate partner.

ASU research reveals gun violence problem begins at home

In one of the first long-term studies to track parenting, delinquent behavior and guns, ASU researchers found that boys whose parents were less involved and communicative with them during childhood were significantly more likely to carry a gun during their teen years. The findings, published in the journal *Pediatrics*, demonstrate the value of involved parents in gun violence prevention programs.



**From the far reaches of deep space
to subatomic particles,**

**ASU is ushering in a vast new
era of discovery, creating impact
on a global, national and
personal level.**

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