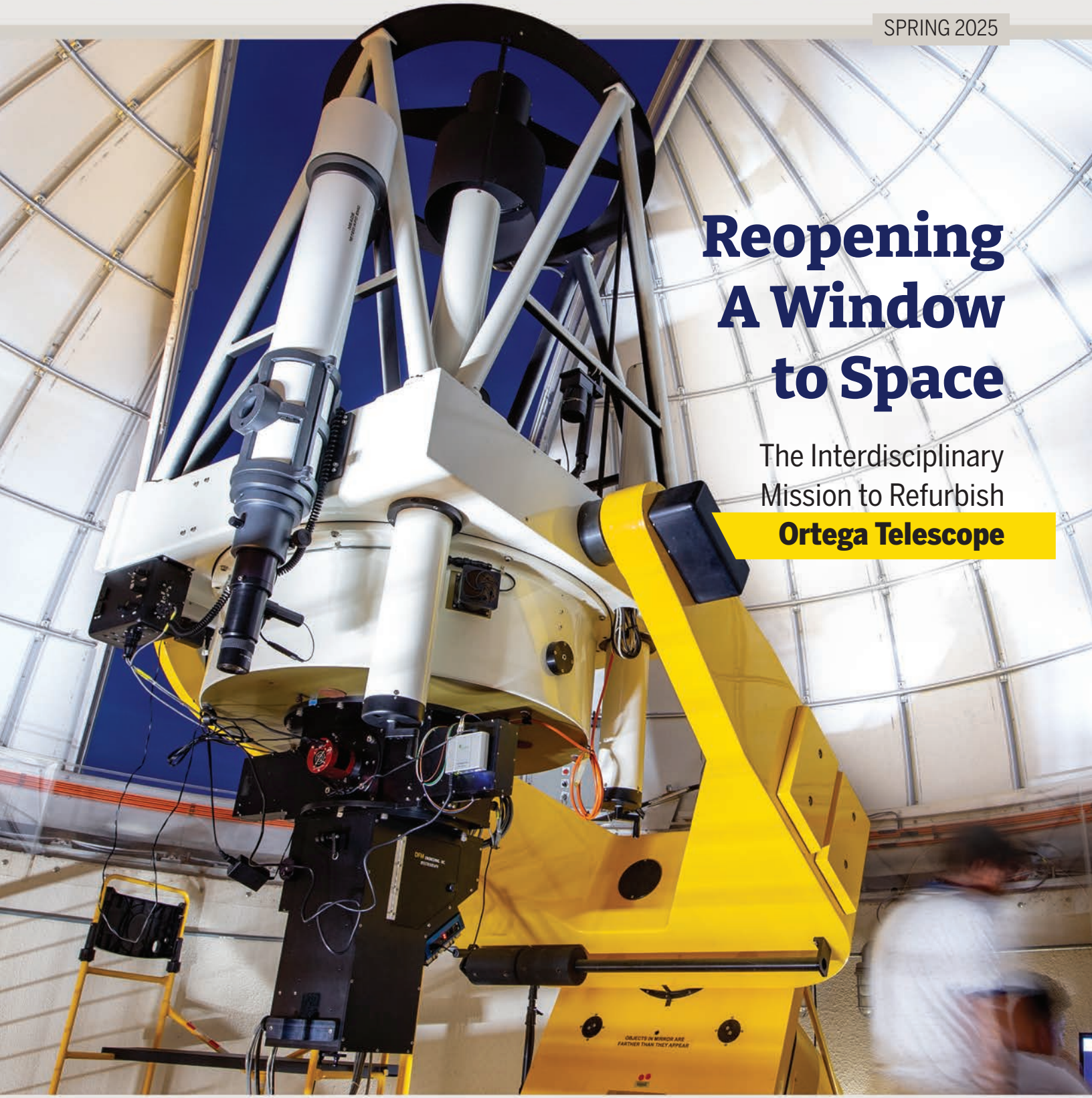
FLORIDA TECH

RESEARCH

SPRING 2025



Reopening A Window to Space

The Interdisciplinary Mission to Refurbish **Ortega Telescope**

In This Issue

Spring 2025 • Volume 1, Issue 1

Florida Tech's Department of Ocean Engineering and Marine Sciences has a new tool for assessing how biofouling may affect ship power. Assistant professor Travis Hunsucker designed and built a flow tank that measures the effects of drag between water flow and biofilm. Tim Patschorke, above, one of Hunsucker's students, is operating the machine. Located at the Mertens Marine Center, it subjects naturally grown biofilm to different rates of water flow to explore how water flow erodes biofouling on ships in motion and how that erosion conserves energy.

A MESSAGE FROM THE PRESIDENT

John Nicklow, Ph.D.

Welcome to a tour of Florida Tech's mind.

In these pages you will see the results of vision and hard work, of curiosity as motivation, of seeking and discovery.

In other words, academic research.

Research is one of the most important contributions higher education makes to society. At Florida Tech, research is a bit different than elsewhere because we empower and encourage our undergraduates to conduct research alongside our graduate students and faculty, and many have produced papers and presented at conferences as a result.

So while research is of course about the findings, the research process itself is extremely powerful in its own right, exposing these young explorers to critical knowledge, the value of collaboration, and experiences that will set them apart after graduation.

You will read about both versions of research in the pages that follow, meeting some of the students and faculty that keep our labs bustling and equipment humming.

There is a dedication monument in the university's Olin Quad from the opening years ago of our F.W. Olin Engineering and Science Complex. Its inscription captures why Florida Tech is the powerful research institution it is—and why it continues to build toward even more research, more funding, more breakthroughs.

It reads: "Dedicated to the Relentless Pursuit of Knowledge for the Betterment of Mankind and the Planet on Which We Live." That "Relentless Pursuit" is part of our DNA at Florida Tech; it sets the tone for who we are and what we value.

I am pleased you now have before you a guidebook to a few of our relentless pursuits. Please enjoy this issue of *Florida Tech Research*.

A MESSAGE FROM THE CHIEF RESEARCH OFFICER

Hamid Rassoul, Ph.D.

Florida Tech was founded in 1958 as a night school for technicians at the Cape. As we grew beyond these early days, adding labs and increasing research, our initial focus was on two mysterious and important places: space and the oceans.

As you will discover in the pages to follow, those topics remain priorities for our students and faculty—and for the wider world. But you will also see they are far from the only areas of attention at Florida Tech.

We have highlighted several of the university's exciting initiatives in this issue of *Florida Tech Research*. For example, a cluster of faculty and students from different engineering and science disciplines has come together to refurbish our Ortega Telescope. We'll introduce you to a psychologist whose research on sociality in rhesus monkeys could help develop a more precise way of treating autism.

Additionally, we tell you about a remotely operated vehicle built by seniors that someday could replace scuba divers in hazardous underwater cave mapping, and we'll explore the origins of life through the power of modeling.

Representing multiple disciplines across our colleges of science and engineering, aeronautics, business and psychology and liberal arts, the research showcased here is united by what motivates our community of learners: the pursuit of understanding and a desire to improve the human condition. Thank you for sharing in our quest, and please enjoy *Florida Tech Research*.

FLORIDA TECH RESEARCH

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The Monkey Model:

How Boosting a Hormone in Monkeys Points to Potential Autism Treatment

CATHERINE TALBOT EXPLORES VASOPRESSIN'S IMPACT ON LOW-SOCIAL RHESUS MONKEYS

By Madeline Taylor

For years, Florida Tech's Catherine Talbot, assistant professor of psychology, has worked to understand the sociality of male rhesus monkeys and how low-social monkeys can serve as a model for humans with autism. Her most recent findings show that replenishing a deficient hormone, vasopressin, helped the monkeys become more social without increasing their aggression—a discovery that could change autism treatment.

Currently, the Centers for Disease Control and Prevention report that one in 36 children in the United States is affected by autism spectrum disorder (ASD). That's an increase from one in 44 children reported in 2018. Two FDA-approved treatments currently exist, Talbot said, but they only address associated symptoms—not the root of ASD. The boost in both prevalence and awareness of the disorder prompts the following question: What is the cause?

Some rhesus monkeys are naturally low-social, meaning they demonstrate poor social cognitive skills, while others are highly social. Their individual variation in sociality is comparable to how human sociality varies, ranging from people we consider social butterflies to those who are not interested in social interactions, similar to some people diagnosed with ASD, Talbot said. Her goal has been to understand how variations in biology and behavior influence social cognition.

In the recent research paper published in the journal *PNAS*, "Nebulized vasopressin penetrates CSF [cerebral spinal fluid] and improves social cognition without inducing aggression in a rhesus monkey model of autism," Talbot and researchers with Stanford, the University of California, Davis and the California National Primate Research Center explored vasopressin, a hormone that is known to contribute to mammalian social behavior, as a potential therapeutic treatment that may ultimately help people with autism better function in society. Previous work from this research group found that vasopressin levels are lower in their low-social rhesus monkey model, as well as in a select group of people with ASD.

Previous studies testing vasopressin in rodents found that increased

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The researchers monitored male rhesus monkeys' behavior after giving them vasopressin.

Vasopressin "rescued" low-social monkeys' ability to respond prosocially to others and to remember new faces. The treatment was successful.

hormone levels caused more aggression. As a result, researchers warned against administering vasopressin as treatment, Talbot said. However, she argued that in those studies, vasopressin induced aggression in contexts in which aggression is the socially appropriate response—such as guarding mates in their home territory—so the hormone may actually be promoting species-typical behavior.

She also noted that the previous studies tested vasopressin in "neurotypical" rodents, as opposed to animals with low-social tendencies.

"It may be that individuals with the lowest levels of vasopressin may benefit the most from it—that is the step forward toward precision medicine that we now need to study," Talbot said.

In her latest paper, Talbot and her co-authors tested how low-social monkeys, with low vasopressin levels and high autistic-like trait burden, responded to vasopressin supplementation to make up for their natural deficiency. They administered the hormone through a nebulizer, which the monkeys could opt into. For a few minutes each week, the monkeys voluntarily held their face up to a nebulizer to receive their dose while sipping on white grape juice—a favorite among the monkeys, Talbot said.

After administering the hormone and verifying that it increased vasopressin levels in the central nervous system, the researchers wanted to see how the monkeys responded to both affiliative and aggressive stimuli by showing them videos depicting these behaviors. They also compared their ability to recognize and remember new objects and faces, which is another important social skill.

They found that normally low-social monkeys do not respond to social communication and were better at recognizing and remembering objects compared to faces, similar to some humans diagnosed with ASD. When the monkeys were given vasopressin, they began reciprocating affiliative, pro-social behaviors, but not aggression. It also improved their facial recognition memory so that it became equivalent to their recognition memory of objects.

In other words, vasopressin "rescued" low-social monkeys' ability to respond

prosocially to others and to remember new faces. The treatment was successful.

"It was really exciting to see this come to fruition after pouring so much work into this project and overcoming so many challenges," Talbot said of her findings.

One of Talbot's co-authors has already begun translating this work to cohorts of autism patients. She expects more clinical trials to follow.

In the immediate future, Talbot is examining how other, more complex social cognitive abilities like theory of mind—the ability to take the perspective of another—may differ in low-social monkeys compared to more social monkeys and how this relates to their underlying biology. Beyond that, Talbot hopes that they can target young monkeys who are "at-risk" of developing social deficits related to autism for vasopressin treatment to see if early intervention might help change their developmental trajectory and eventually translate this therapeutic to targeted human trials.

Catherine Talbot

Applications in Autism: Finding Precise Treatment

With help from research like Catherine Talbot's, scientists continue to search for and develop more precise treatments for autism spectrum disorder (ASD). The potential for new therapies is exciting.

Currently, there are no medications that treat the core symptoms of autism: persistent communication and interaction difficulties and repetitive behavior. However, the Food and Drug Administration (FDA) has approved two antipsychotic drugs to treat certain symptoms associated with autism: risperidone and aripiprazole. These drugs can help treat irritability, but don't treat the root of the disorder.

Beyond pharmacological options, different therapies can help treat certain ASD symptoms. Those include (but are not limited to) speech-language therapy, occupational therapy and applied behavior analysis (ABA).

Applied behavior analysis (ABA) is a therapy rooted in our understanding of behavior and how it applies to real world situations. ABA programs can help patients improve their language and communications skills, attention, focus, social skills, memory and academics. It can also help patients decrease problem behaviors.

Florida Tech's Scott Center for Autism Treatment serves children and adolescents with autism spectrum disorder in Central Florida. Its Autism Services clinic boasts experts in the assessment and treatment of challenging behaviors, early intervention, intensive toilet training, pediatric feeding, and parent and teacher training.

AUTISM PREVALENCE

1 IN 36 CHILDREN
in the U.S. have autism, up from the previous rate of 1 in 44.

4 IN 100 BOYS & 1 IN 100 GIRLS
Approximate incidence of autism by gender in the U.S. Boys are nearly 4 times more likely to be diagnosed than girls.

1 IN 45 ADULTS
in the U.S. have autism

*The CDC autism prevalence estimates are for 8-year-old children across 11 monitoring sites in the Autism and Developmental Disabilities Monitoring (ADDM) Network in 2020.
Source: Centers for Disease Control and Prevention (2023)

Reopening A Window to Space

Florida Tech Students and Faculty Carry Out Interdisciplinary Mission to Refurbish Ortega Telescope

By Madeline Taylor

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When Luis Quiroga-Nuñez, Ph.D., was appointed director of Florida Tech's Ortega Observatory and its primary tenant—a non-functioning, 32-inch telescope—in 2023, he decided it was time to provide astronomy students and others a window to space.

The observatory is already a base for research across a spectrum of cosmic exploration through disciplines such as astronomy and astrophysics, heliophysics, planetary science and astrobiology. But current students have yet to see the stars up close as the aging telescope, commissioned in 2008, has sat dormant for the last several years.

With restoration, the telescope could serve as a powerful tool to train students to use professional telescopes and make observations – critical skills that will help prepare them for their future careers.

It soon became apparent, however, that this was no simple task. The restoration would necessitate reverse engineering on a large scale to even understand how to fix and upgrade the telescope, much less actually repair it. It would also, as Quiroga-Nuñez wisely recognized, be its own powerful educational opportunity, providing unique hands-on-learning opportunities for students in the College of Engineering and Science.

"We are an institute of technology. We have perfectly capable people, like these young students, ready to join hands-on projects, get crazy and start to be creative," Quiroga-Nuñez said.

With a variety of issues to tackle and eager to support home-grown expertise, Quiroga-Nuñez and Lee Caraway, Ph.D., an instructor in the department of electrical engineering and computer science, recruited students with varied backgrounds, from astronomy to electrical engineering and computer science. Students could apply what they learned in class and grow their portfolios with a real-world project,

> "We are an institute of technology. We have perfectly capable people, like these young students, ready to join hands-on projects ..."
>
> —Luis Quiroga-Nuñez, Ph.D.

the sort of experiential learning that is a hallmark of a Florida Tech education.

Some improvements have been made, but the project remains an exciting puzzle for both students and faculty alike to solve. Here's how they are doing it.

AN INTERDISCIPLINARY PROJECT

In January 2023, Quiroga-Nuñez partnered with Caraway to rebuild the telescope from the inside out. They say the conversation started over lunch, sketching ideas on a napkin.

With a variety of issues to tackle and eager to support home-grown expertise, Caraway and Quiroga-Nuñez recruited students with varied backgrounds, from astronomy to engineering to computer science.

"This is about as real world as you can get without leaving school. We have this giant piece of technology that is not working. Figure out why," said recent graduate Adrianna Agustin '24, who helped update the telescope's communication system. "All of those problem-solving skills will directly translate to wherever we go in the future."

The multidisciplinary nature of the project is also boosting collaboration between both sides of the college.

"We keep integrating different parts of the university and involving students in a project that we were blinded by," Quiroga-Nuñez says. "We sit between the scientists and the engineers."

And there's no shortage of tasks. In addition to the refurbishment, Quiroga-Nuñez and Caraway are also completing routine telescope maintenance with students taking on adjacent projects around the observatory.

With the telescope repair, each student is given their own task, such as redesigning a small clip that supports the dome's electric current, reviewing the conditions of the finder's lens or understanding how analog devices were controlling the focus of the telescope. This allocation allows each student to claim their own individual contribution to the greater telescope puzzle.

OPENING A TIME CAPSULE

The telescope's biggest issues were mechanical and electrical—all exacerbated by age.

Its motors were decades old and naturally failing, Caraway said. These motors controlled the telescope's right ascension and declination—essentially, its ability to move. The chaotic interior also involved multiple individual systems with dozens of wires.

And the circuits controlling the motors, which dated back to the 1980s, were also failing due to age. As Caraway noted, his students are sweeping off "dust older than them."

"The technology back then simply did not exist to control the motors,

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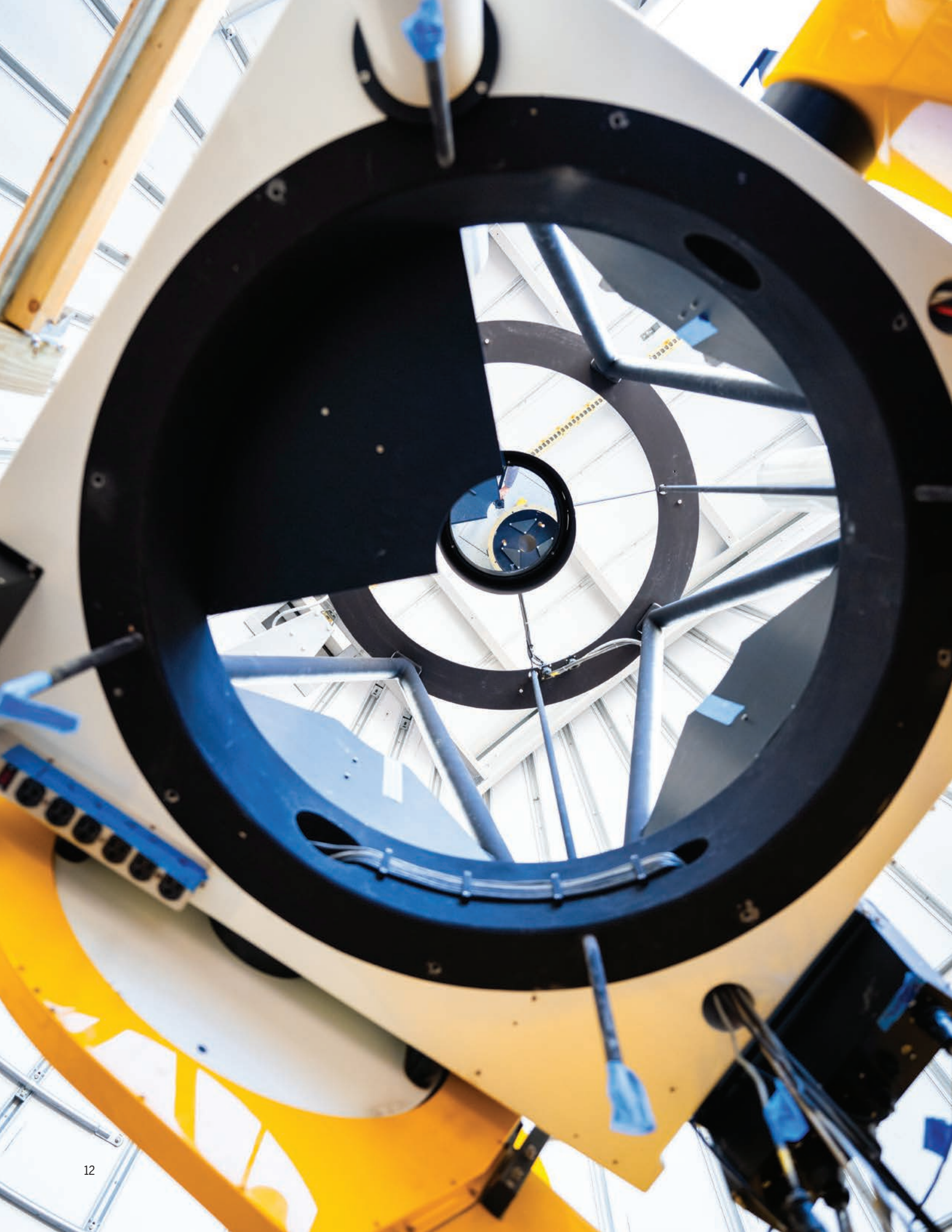
« Students Ian Houston and Lennox Krell discuss safe reinstallation of the telescope's primary mirror using a digital, 3D rendering of the observatory.

» Left: Student Lennox Krell uses a multimeter to test the electrical properties of one of the observatory's dome control boxes.

Right: Student Kellen Lucchesi works to untangle old telescope wiring. Some wires will be reused, while others will be removed or replaced.



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run the diagnostics and make it all happen," Caraway explained. "They're not designed to run 30 years."

Additionally, the computer program that controlled the motors was outdated and did not meet to the university's security requirements.

Given all of this, the team needed to develop a new communication system for the telescope, starting with the computer software. They decided that instead of trying to purchase upgraded computer system, they could build and program their own from scratch, here in-house.

Next, once the new computer was up and running, it needed motors to command. Marisa Guerra '24 worked on a senior design project involving a robotic arm whose motor structure was the same as that of the telescope's. Using what she learned for her capstone project, she crafted a blueprint for the telescope's new motors.

At the same time, Agustin worked on developing a cleaner communication system between the computer to the motors. Her senior design research focused on electric vehicles and their internal circuit systems, and she was able to replicate something similar within the telescope—but not without digging through the decaying electronics first.

"We had to reverse engineer and actually redraw the circuits, which was good practice because a lot of the times, for senior design at least, you don't really have to design a new circuit. You are just kind of puzzle-piecing it together," Agustin said. "But with this circuit, all of them were bad."

Using Guerra's and Agustin's senior design research, the team reprogrammed the telescope's circuits. What once took 20 wires to operate now only takes two. They also reduced the weight of the telescope's motors from 40 pounds to just 2 pounds.

Once the communication system was finished, the team was just waiting on mobility. And on a day in Spring 2024, thanks to the refurbished system, they were able to create movement within the telescope for the first time in years.

"I didn't even know if that device could move internally," Quiroga-Nuñez says.

The moment was celebrated, but the team knew that this success triggered a new challenge. It was time to tackle high astrometric precision—a crucial element of properly tracking movement in space.

"We are pointing to tiny points in the sky. If we do not track that properly, we are going to be lost in the universe," Quiroga-Nuñez says.

THE VALUE OF TIME

Perfecting precise movement is expected to take some time, but that's not a bad thing, Quiroga-Nuñez says. He believes that a lengthy timeline will offer more value in the long run because it will give even more students a chance to get involved. Besides, its primary purpose will be to teach students how to use a telescope and allow them to make observations and prepare for their future careers.

Ultimately, Quiroga-Nuñez predicts that that the telescope could pick up its first image from space in about a year if everything stays on track. However, the team still has a lot of ground within the telescope to uncover, with an unpredictable number of potential challenges to troubleshoot.

For example, while rebuilding the motor, they discovered that the internal mirror that illuminates the telescope's visuals was in poor condition – it needed cleaning and new aluminum to reflect enough light to see the telescope's imagery, Agustin explains. So, the team had to remove the mirror and ship it to New York for refurbishment—a process that took several months. Once the mirror is reinstalled, they can pivot back to their quest for better precision.

The mirror is just one example of unpredictability in reverse-engineering. Ultimately, dedicating more time in understanding and solving the unforeseen challenges allows more students to take part in the telescope's journey, Quiroga-Nuñez says.

"This is like a big Lego for them," he says. "They are learning the process, and the students, I think, will have found a very valuable life experience."

» Students Jacopo Ghezzi, Landon Schreck and Kellen Lucchesi explore the new, custom software that will control the telescope and dome to follow celestial objects accurately.

Student-Built Vehicle May Help Divers Avoid Hazardous Missions

REMOTELY OPERATED TEC-V DESIGNED TO MAP HARD-TO-REACH CAVES // By Madeline Taylor

Ocean engineering seniors Stephen Coster and Henry Hill are avid scuba divers. Through their training, they know that some underwater environments, such as enclosed caves, can be dangerous for humans to explore. So for their senior design project, they decided to create a device that can map caves on its own.

Meet TEC-V.

TEC-V, which stands for Topographic Exploration Cave Vehicle, is a small, cylindrical, remotely operated vehicle (ROV). It is nine inches tall, 14.3 inches wide and 26.7 inches long; that's close to the size of a standard scuba diving tank. It weighs 24 pounds and can operate at depths of up to 100 meters (a bit longer than the length of a football field). It's also equipped with side-scan sonars to produce images up to 100 meters away.

The ROV aims to replace scuba divers when surveying hazardous enclosed environments to document otherwise difficult-to-gather data. It can also explore Florida's aquifers, survey shipwrecks, monitor ports and harbors and support autonomous underwater vehicles.

"The overarching goal, from the beginning and still to this day, is to build a small, simple ROV that's really modular so you can use it for a bunch of different applications," Hill said.

TEC-V's carbon fiber fairing is hydrodynamic, visible underwater and rigid enough to protect its internal systems.

How does it work? The operator controls the ROV via joystick. Once in an enclosed space, it completes a full sideways rotation; its round, Twinkie-like build creates an efficient, hydrodynamic roll. While rolling, it sends out sonar pings which plot a cylindrical map of the area. It can identify anything from nearby sharks to umbrellas.

Coster and Hill were originally inspired by a graduate-level project they collaborated on their freshman year. That instrument was also designed to map caves, but autonomously. However, the design did not get far, so the two undergraduates were encouraged to make it their own, Coster said.

> "The overarching goal is to build a small, simple ROV that's really modular, so you can use it for a bunch of different applications."
>
> —Henry Hill, ocean engineering senior

To create their own system, they enlisted mechanical engineering student Gabor Papp and computer science student Mike Dowling for assistance.

"Between me and Henry being the ocean engineers, and having mechanical and computer science engineers, it's a very multi-disciplinary project," Coster said. "It has to be for what we're trying to do, because not any one group can do everything."

The team spent countless hours learning how to structure the system, from understanding its buoyancy to mapping out how the different components can communicate. Once they had a grasp on TEC-V's functionality, they could focus on its design. Its yellow, carbon fiber fairing is hydrodynamic and easy to spot and provides rigid protection for its internal systems. Several drain holes also ensure that water can escape the ROV in less than five seconds.

"We made our initial designs. They were criticized heavily," Coster said. "We just kept going, iteration after iteration, creating something that would work."

Over six months, the team deployed TEC-V in various locations, including the Mertens Marine Center, Port Canaveral and several spots west of Florida's Marquesas Keys during the department's Marine Field Projects (MFP) cruise.

There, they found that TEC-V didn't just work, it worked well. While on the MFP cruise, the team thought they found a shipwreck based on objects they could see from the water's surface. Instead of sending divers to check it out, they tested the ROV's ability to map the site.

"Using the sonar, we could see that it was actually a reef, it wasn't a shipwreck," Coster said. "We saw sharks and stuff ... it was absolutely amazing how useful [TEC-V] was."

The ROV may be fully functional, but Hill and Coster said it still needs some work to complete their vision. Next, they'll focus on improving its software to better filter erroneous data points and to create a more digestible data plot. They also want to change some of TEC-V's design to make its roll more efficient. Eventually, they would like the device to function autonomously. Much of that, however, will be up to the next generation of ocean engineering seniors.

AT A GLANCE

TEC-V

TOPOGRAPHIC EXPLORATION CAVE VEHICLE

SIZE: 14.3” wide x 26.7” long x 9” tall, about the size of a standard scuba tank

WEIGHT: 24 pounds

RANGE: Depths of up to 100 meters, a bit longer than the length of a football field

FEATURES: Side-scan sonar to produce images up to 100 meters away

USE CASES: Remotely operated vehicle for surveying hazardous enclosed environments, including caves, aquifers and shipwrecks

Research Below the Surface

SCUBA DIVING REMAINS AN ESSENTIAL RESEARCH TOOL EVEN AS TECHNOLOGY EVOLVES

By Madeline Taylor

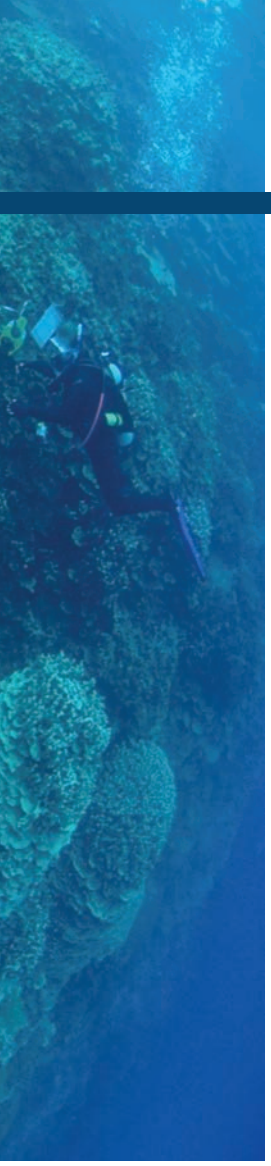
The roots of scuba diving lie in exploration. But in an age when advanced instruments can drive research too, why not stay dry on land?

Researchers have used scuba diving as a tool for decades but as technology evolves, remotely operated vehicles (ROVs) can aid, and sometimes replace, divers in the research process. Still, argues Stephen Wood, no existing tools have the full capability of a human.

The professor of ocean engineering says the ability to grab items or quickly turn one's head is difficult to replicate in an ROV. He also argues that although robots can collect and send data, the ability to assess and interpret an environment through a human lens is essential.

"The human cannot leave" the research, Wood says.

The American Academy of Underwater



Sciences (AAUS) defines scientific diving as "diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks." With more than 140 organizational members, AAUS exists to support diving as a research tool and protect the health and safety of scientific divers.

Researchers and students are required to obtain an AAUS certification, which Florida Tech offers, before undertaking a scientific dive. At Florida Tech, any diver who plans to use compressed air or air blends for activity involving teaching or research must comply with AAUS.

Robert van Woesik, professor of marine sciences, studies the dynamics of coral reefs around the world. He and his students scuba dive to examine and photograph coral assemblages, then return with information they can use to predict the impact of local and global disturbances, recovery from disturbances and future growth.

The ability to personally identify different species underwater is crucial to the understanding of coral reef dynamics, and without scuba, the necessary training to develop that skill falls away, he says.

"I think it's still worthwhile knowing the species composition of a reef underwater instead of just saying, 'Okay, we don't need scuba divers anymore. We just need photographs and ROVs,'" van Woesik says.

He learns the most when he's able to descend to a reef and see the seascape himself.

"I think there's something to be said to just go in the water and ask some questions," van Woesik says. "That's the valuable part of being able to scuba dive, getting amongst it to experience the reef, in tandem with analyzing photographs from around the world on the computer."

Assistant professor of marine sciences Austin Fox says in his research in the Indian River Lagoon, diving is essential for operating—and sometimes finding—instruments.

"We spend a lot of time trying to figure out ways to do this stuff without diving ... but there's just no replacement for it," he says.

Scientific diving has taken Florida Tech researchers across the globe, from the murky floor of the Indian River Lagoon to the depths of Antarctica's McMurdo Sound.

Rich Aronson, department head and professor of ocean engineering and marine sciences, studies coral reefs in the tropics and subtidal communities in Antarctica. In 1997, he had the opportunity to visit the McMurdo Station to study invertebrate ecology—specifically, who eats what and whether they leave traces of their predatory activity on the shells of their prey.

There, he completed 27 dives of up to 130 feet deep. Some were done through ice-cracks in remote areas, he recalls, whereas others were from holes drilled through 10 feet of sea-ice. He noted that the time to prepare for these dives was extensive—two 30-minute dives took eight hours—and they weren't without risk.

"That was the first and only time I've dived under the ice. It's dangerous because there's a ceiling above you," Aronson says. "You jump in the hole and try not to screw it up because if you screw it up, you're dead."

Though risky, Aronson says scuba diving was crucial to the research. He argues that neither ROVs nor oceanographic sensors could have collected or sampled organisms at fine scales, run transects and made behavioral observations like a human could.

Additionally, he says his observations at depth, such as the "sting of subzero water" on his face and "the slowness of reaction of the animals living down there," are what later inspired a project of his combining deep-sea oceanography and paleontology to project the future of Antarctic seafloor communities in a rapidly warming world.

"Science is a lot more subjective than you might think, and feeling the environment helps you understand it," Aronson says.

The risky nature of scuba diving is why programs like AAUS exist: to standardize safe and responsible diving practices for conducting scientific research.

Divers are at risk for a number of pressure-related injuries, such as decompression sickness: a condition in which residual nitrogen can create bubbles in the blood and body tissue upon ascent if the diver rises to the surface too fast. To reduce their risk, divers must plan and track how deep they are going, the time at which they are that depth (and subsequent depths) and how long they need wait before changing depth.

Technology has also evolved since the beginnings of scuba to further support the safety of divers.

Digital dive computers, developed in the 1980s, help divers estimate how long they can stay at their current depth while underwater (among other things). Additionally, Enriched Air Nitrox (Nitrox) is a gas mixture that contains a higher percentage of oxygen than standard air. Divers who use Nitrox can extend their time at depth and reduce their risk of decompression sickness because of its reduced nitrogen pressure.

Van Woesik predicts that dive technology will keep evolving. He imagines there could soon be a system that allows divers to upload data at depth, and a system that aids in species identification without having to decipher an image at the surface.

He also believes that innovators will keep working to reduce hazards and prioritize safety, because despite the risks, divers will always be getting in the water.

"Hopefully that technology will get better so we can go deeper, safer, and so we can stay down a bit longer to explore and further understand the natural wonders of the oceans," van Woesik says.

Origins of Life

MANASVI LINGAM USES POWERFUL DATA MODELS TO EXPLORE WHERE LIFE COULD HAVE EMERGED ON EARTH

By Madeline Taylor

Florida Tech astrobiologist Manasvi Lingam has asked life's biggest questions from a young age. Though he can't recall his exact queries, he says his interests were perfectly consistent with those of other children: dinosaurs and aliens.

On bus rides with his family, he would pepper his parents with questions about the mysteries of the universe. On long walks with his grandfather, he would brainstorm how life could exist on different types of planets.

Lingam's fascination with early life and astrobiology never waned. Now an assistant professor of astrobiology, he has gone from asking his grandfather questions to creating his own models to explore complex topics such as the origin of life. He exchanged the pursuit of definitive answers for scholarly inferences, embracing the universe's uncertainties by exploring chance.

According to Lingam, models – or simplified representations of reality – accomplish two main tasks: they help researchers make predictions and they offer an alternative to experiments that may be too costly or impractical. That was the case with Lingam's recently published analysis regarding the potential origin of life on Earth.

Manasvi Lingam

"A Bayesian Analysis of the Probability of the Origin of Life per Site Conducive to Abiogenesis," published Aug. 19 in the journal Astrobiology by Lingam, recent Florida Tech graduate Ruth Nichols and University of Rome astrobiologist Amedeo Balbi, models the relationship between hypotheses predicting varying numbers of potential sites for abiogenesis – the emergence of life from non-life – on Earth and the likelihood of life's emergence at those sites.

A Bayesian analysis is one in which prior knowledge is used to estimate subsequent probability. For the sake of this model, the researchers focused on the possibility of life originating on Earth itself. So, since it's established that there is life on Earth, this model assumes that life originated on Earth at least once.

Lingam says this is one of his first times specifically studying the origin of life. However, he's modeled several adjacent questions, such as the evolution of technology-based intelligence.

The researchers compiled potentially urable sites – those viable for life to start – identified in previous research, each with different levels of conduciveness for the genesis of life. They included several different environments, ranging from underwater volcanoes to soap bubbles and tar to natural nuclear reactors akin to one that formed in Gabon two billion years ago.

Two main questions shaped their models: from how many sites on Earth could life have emerged; and what is the probability of life actually emerging from one of those sites? The goal of the study was not to directly answer the questions but to find the most accurate way of interpreting the data the models generate.

The researchers modeled three different scenarios: one with 10 urable sites; one with 1031 (that's 10 million-trillion-trillion, or 1 followed by 31 zeroes) urable sites; and one close to the middle with 1016 urable sites.

Lingam initially anticipated that access to larger pools of urable sites would create a higher likelihood of life emerging on Earth. Think when you buy more lottery tickets, your chances of winning will go up.

Instead, the results were the complete opposite in this agnostic scenario. Lingam found that when comparing the larger number of sites to the smaller number, the probability of life per pool was almost inversely related to the number of pools.

"That's the two situations that are here. One where there are lots of sites, but there's very low probability [of life] per site. And the second where there are very few sites, but there's a very high probability per site," Lingam says.

Yes, this outcome is counterintuitive, he says. That's why it's important.

"Normally 'the more, the better' is the attitude for many things in life," Lingam says. "But more is not always better. If it's fewer, but it's the right kind of fewer, then that can actually be better."

In other words, in the model where Earth had fewer urable sites overall, the researchers inferred that the probability of life emerging on a given site is enhanced. They established that a greater chance of generation of life could be more likely when urable sites are rare, and plentiful urable sites might lessen the likelihood of life from a given site.

From there, they drew the inference that the smaller sample of sites, which revealed a higher probability of life at a given site, likely contained more conducive environments.

Their findings suggest that within the Bayesian framework, placing constraints on the availability of suitable environments for the origin(s) of life on Earth may offer valuable insights into the probability of abiogenesis

and the frequency of life elsewhere in the universe.

How could these findings be used?

Since researchers have different opinions on the most likely environments for life to emerge, Lingam says they can use this model in the context of understanding their preferred environments.

"Then they can do laboratory experiments, try to get a feel for how many trials might be needed to actually move to something like life," Lingam says.

Lingam would also like to continue building an understanding of early life by exploring the origins of intelligence.

Although he may not be able to directly answer his childhood questions, Lingam embraces the limitations and uncertainty that accompany his models.

"We can't peer back in time," Lingam says. "Sometimes you can arrive at answers just through very clever use of limited data… but there is a part that you'll never know."

From his upbringing marked by curiosity to his flourishing career in astrobiology, Lingam is committed to his dedication to the wonders that have always captivated him.

"I think this was something every kid goes through, but I took it very seriously," Lingam says. "It feels like, after a long winding voyage, [I'm] coming back to this childhood road."

Not Just STEM: Modeling Used Across Disciplines

Products of computational modeling are all around us, from the morning weather forecast to the route your phone recommends you take to work. Models, or simplified, mathematical representations of real-world situations, are used to support research across a wide array of disciplines by making complex data more accessible.

Manasvi Lingam, an astrobiologist and assistant professor of aerospace, physics and space sciences, says modeling is useful for both generating data-driven predictions and for simulating experiments that would otherwise be too costly or impractical to undertake.

"It's a simplified description of reality that nonetheless captures the aspects of reality you're trying to understand because you cannot capture the full universe in its complexity," Lingam says.

Rich Griffith, an industrial and organizational (I/O) psychologist and professor in the School of Psychology, says the ability to synthesize data and make predictions using mathematical models or machine learning is critical in his future-focused field.

Rich Griffith

One of Griffith's projects examined customer experience at Orlando International Airport. Using self-reported data from customers and employees, he developed a mathematical model that showed a correlation between high employee satisfaction and high customer satisfaction. From there, he inferred that the airport could improve customer experience by improving employees' work experiences.

"It tells us where to focus our energy," Griffith says. "We can use those simplifications to say, 'How would we solve this problem?'"

Alina Malkova, an economist and professor in the Bisk College of Business, says for her, models help visualize ways in which results can apply to other situations. She recently published research analyzing small businesses' borrowing habits during times of uncertainty through the lens of the COVID-19 pandemic.

Alina Malkova

Using data that reflects small-business owners' demands for either traditional bank loans or peer-to-peer loans during the pandemic, she developed a model that explored how unpredictable, restricted physical access to financial institutions could affect borrowing habits in the future. Through this, she inferred that borrowers preferred peer-to-peer loans over bank loans in a time of uncertainty.

"Models are really important in explaining how a story can be told in a completely different framework," Malkova says.

With an eye on their future careers, College of Aeronautics instructor Anna Marron teaches her students how to generate and interpret jet noise models for U.S. airports using the program AEDT (Aviation Environmental Design Tool). She says noise and emissions are two of the biggest environmental concerns in the industry, and models help airport designers and consultants predict areas affected by noise to then find ways of reducing it.

Anna Marron

The ability to assess how different designs could influence noise levels is crucial, Marron says, as a lot of simulation software found in airports can guide federal financial decisions.

"Being able to run multiple scenarios to decide which is the best route moving forward is the most valuable part of [modeling]," Marrons says. "We're not just guessing which is going to be the best way...we can actually run discrete models and decide which will be the best route forward."

RESEARCH IN BRIEF

FACULTY AND STUDENTS ATTEND ARRAY OF CONFERENCES IN 2024

Faculty members and their students attended conferences across the world in 2024.

In September, doctoral students Megan Mark and Dylan Goldberg attended and presented at the 37th International Conference on Lightning Protection in Dresden, Germany with senior visiting research faculty Amitabh Nag, who along with senior visiting research faculty Ken Cummins serves as the students' research co-advisor. (Their principal advisor is Distinguished University Professor Hamid Rassoul.) The two students received Young Scientist Awards, the highest honor for early-career scientists at the event.

Mark's award-winning presentation was, "High-Speed Video Camera and Geostationary Lightning Mapper Measured Signatures of Cloud-to-Ground Strokes with and without Significant Continuing Current," and Goldberg's was, "Optical and electromagnetic field signatures of space-leader evolution in negative cloud-to-ground lightning stepped leaders."

Also in September, associate professor Darby Proctor, assistant professor Catherine Talbot and undergraduate psychology student Brooke Yates attended the 46th Meeting of the American Society of Primatologists in Mexico. They showcased their recent research on spider monkey behavior across several presentations. Yates, who attended virtually, is one of Talbot's honors thesis students. She presented her research on the evolution of play behavior in spider monkeys.

In July, associate professor Toby Daly-Engel attended the Joint Meeting of Ichthyologists and Herpetologists in Pittsburgh with several students: post-doc Anna Weber; Ph.D. students Shannon Barry, Eloise Cave and Naomi Scott; master's student Makenna Beehler and Lila Xenakis; and undergraduate students Dylan Gore and Riley Wallace. They presented on topics including shark genetics, modeling, kinship and other areas under study at Daly-Engel's Shark Conservation Lab.

"To have undergrads working at this level is really rare and a huge an endorsement of our student research program," Daly-Engel said.

In March, associate professor Andrew Palmer led students studying ocean engineering and marine science, biomedical engineering and science and aerospace, physics and space sciences at the regional meeting of the American Society of Plant Biologists at the Dauphin Island Sea Lab in Alabama. Senior astrobiology major Kara Smoak and junior astrobiology major Aiden Kelly placed 3rd for their poster, "Testing Bacterial Isolates from the ISS for their Plant Growth Promoting Abilities." Sergio Solano, a master's student in cell and molecular biology, placed 3rd in the oral presentations for his talk, "Evaluating the Use of Aquatic Plants in Martian Agriculture."

> "To have undergrads working at this level is really rare and a huge endorsement of our student research program."
>
> — Toby Daly-Engel, Ph.D.

$2.3M GRANT WILL FUND HIGH-PERFORMANCE COMPUTING

Florida Tech received $2.3 million in funding from the National Institute of Standards and Technology (NIST) to expand its AI.Panther high-performance-computing cluster as the university prepares for a new wave of artificial intelligence.

The project, "Leveraging High Performance Computing and Artificial Intelligence for Enhanced Cybersecurity, Resilience and Innovation in Aerospace and Defense Industry," complements Florida Tech's innovative Aerospace Cybersecurity Engineering Development (ASCEND) program along with other large-scale computational projects.

Florida Tech's research and teaching ranges from methodology and software development to large-scale AI applications in diverse areas, including healthcare, defense, cybersecurity, business analytics and social and behavioral sciences, noted Munevver Mine Subasi, associate provost for academic affairs and principal investigator on the NIST project.

"The expansion of our AI.Panther cluster will provide state-of-the-art computational infrastructure to promote interdisciplinary projects within Florida Tech, facilitate workforce training, and foster university-industry and university-government collaborations, enabling Florida Tech to serve as an intellectual and innovation hub for AI research," Subasi said.

The initiative will help equip students and professionals with the cutting-edge AI skills required to succeed in today's evolving technological landscape. It will also enable collaboration with aerospace and defense sectors, keeping Florida Tech at the forefront of innovation.

GOING FOR A SPIN: EXPERIMENT EXPERIENCES LUNAR GRAVITY FROM ROTATING CAPSULE

The space biologists John Z. Kiss and Karl Hasenstein, working with 4SPACE LLC, designed an experiment in fluid dynamics that was conducted in lunar gravity aboard a rotating Blue Origin capsule during its suborbital journey on Feb. 4, 2025.

The mission, NS-29, represents a hybrid of private and public involvement led by 4SPACE, an innovative new space company that sponsors science payloads with payloads for commercial applications. Blue Origin's New Shepard capsule acted as a centrifuge that created two minutes of lunar gravity for the payloads.

The project compared the effect of lunar gravity on aqueous solutions of different viscosities and their interaction with surfaces at different angles. While water distribution in plants and its percolation through soil is gravity-dependent, we don't know whether the reduced lunar gravity—one sixth of Earth's gravity—can maintain these processes in plants.

"While we know a great deal about biology and fluid dynamics in microgravity, we know little about these processes in terms of the lunar gravity environment," said Kiss, professor and provost at Florida Tech. "This project presented a unique opportunity to test fluid dynamics in lunar gravity to gain insights into the cultivation of plants, which is important for bioregenerative life support on the moon."

MACHINE LEARNING TO DIGITIZE ANCIENT TEXTS

The Indus River Valley civilization thrived starting in 3300 BCE using symbols and signs to communicate. But scholars are torn over one question: Were those characters a language or more akin to pictograms?

Professor of computer science Debasis Mitra and graduate student Deva Atturu '24, funded by a grant from the National Endowment for the Humanities, are working to empower those who will answer that question by developing a machine learning algorithm for identifying and digitizing the Indus civilization's ancient script. The process uses an automated script recognition system.

"Both sides have very strong arguments," Mitra said.

RESEARCHER SPOTLIGHT

NAME: **Adrian Peter**

TITLE: Associate professor of mathematics and systems engineering and electrical engineering and computer science (joint appointment); director, Center for Advanced Data Analytics and Systems (CADAS)

DEPARTMENT/COLLEGE: Department of Mathematics and Systems Engineering and Department of Electrical Engineering and Computer Science/College of Engineering and Science

GENERAL RESEARCH FOCUS: Our Multi-domain, Multi-sensor, Cyber-physical Tactical Exploitation (M2CTE) project addresses a critical need for a robust analytic processing framework capable of supporting autonomous sensing and analytics on the edge—where devices and sensors collect data—with the ability to reach back to the cloud for more improvement

CURRENT RESEARCH FUNDING: $2.19 million

What has you EXCITED about your current research?

We have built our entire infrastructure with the immensely talented graduate and undergraduate students at Florida Tech. Their tireless efforts have led to us delivering practical and operational real-world, machine-learning solutions that make us among the global leaders in machine learning at the edge.

Why is it IMPORTANT to conduct research?

The objective of all research is to advance the frontiers of knowledge in a specific discipline. In my research, we are continually pushing state-of-the-art distributed sensing and edge analytics. Our results have helped transition conceptual ideas and customer requirements into operational solutions that improve situational awareness at tactical edge.

CARROLL SECURES NASA AWARD FOR INTERFACE DESIGN RESEARCH IN MULTI-UNMANNED AERIAL VEHICLE OPERATIONS

NASA's Langley Research Center awarded new funding to Meredith Carroll and her ATLAS Lab to explore ground control station interface design for flight operators managing multiple vehicles during future autonomous air taxi operations. Carroll, a professor of aviation human factors, is studying how interfaces – or visual displays – can be designed to present essential flight information to operators monitoring multiple autonomous vehicles at once while allowing the operators to continuously assess how the vehicles are functioning and when it may be time to intervene. While autonomous air taxis aren't taking flight just yet, current drone operations are being used an analog environment to evaluate potential interface designs.

PEER-TO-PEER BORROWING SURGED DURING PANDEMIC, RESEARCH FINDS

New research by Florida Tech assistant professor of business Alina Malkova, Ph.D explores how small businesses sought financing amid the COVID-19 pandemic's unstable economic environment.

Her paper, "Beyond banks: Navigating the shift to peer-to-peer lending for small enterprises," published in the journal Research in Economics, developed a model to find whether the COVID-19 pandemic affected small-business owners' demand for peer-to-peer (P2P) lending.

Malkova found that more small business owners turned to P2P platforms during this time, primarily because they were more accessible and flexible than traditional banks. Borrowers could access P2P platforms online for convenient use, and the platforms' advanced algorithms gave lenders more information about borrowers, such as neighborhood demographics, leading to a better understanding of their financial situation.

"If you are an owner or borrower and you have short-term financial problems, it may help you," Malkova says. "It helps you signal your situation."

Ultimately, Malkova says P2P platforms played critical role in overcoming financial barriers that inhibited small businesses in times of limited access to traditional funding.

TOP RESEARCH FUNDING BY MONTH, 2024

ORGANIZED BY DOLLAR AMOUNT

OCTOBER 2024

TOTAL AWARDED: **$3,214,286**

LEAD PI: Ratan Jha

DEPARTMENT: Aerospace, Physics and Space Sciences

SPONSOR: Florida Department of Education

AWARD: Florida Tech: Aerospace Cybersecurity Engineering Development – ASCEND

SEPTEMBER 2024

TOTAL AWARDED: **$2,323,000**

LEAD PI: Munevver Subasi

DEPARTMENT: Provost

SPONSOR: National Institute of Standards and Technology

AWARD: ASCEND: Leveraging HPC and AI for Enhanced Cybersecurity, Resilience and Innovation in Aerospace and Defense

NOVEMBER 2024

TOTAL AWARDED: **$1,785,714**

LEAD PI: Marco Carvalho

DEPARTMENT: Renewals and Renovations

SPONSOR: Florida Department of Education

AWARD: Florida Tech: Aerospace Cybersecurity Engineering Development – ASCEND 2

JULY 2024

TOTAL AWARDED: **$942,765**

LEAD PI: Juan C. Avendano

DEPARTMENT: Center for Advanced Manufacturing and Innovative Design

SPONSOR: National Science Foundation

AWARD: Exploring Advanced Manufacturing and Microelectronics to Empower Youth Aging out of Foster Care

JANUARY 2024

TOTAL AWARDED: **$720,000**

LEAD PI: Toufiq Reza

DEPARTMENT: Chemistry and Chemical Engineering

SPONSOR: U.S. Department of Energy

AWARD: Biological routes for synthesizing the industrial platform chemical, propylene, from deconstructed lignin waste and captured carbon dioxide produced during lignin valorization into bio-oil

FEBRUARY 2024

TOTAL AWARDED: **$547,724**

LEAD PI: Juan Carlos Palacios

DEPARTMENT: Aerospace, Physics and Space Sciences

SPONSOR: NASA

AWARD: Investigating the radial evolution of the scaling properties of intermittency in the solar wind

FLORIDA TECH, KSC TO RESEARCH WASTE-TO-ENERGY CONVERSION IN SPACE

Associate professor of chemical engineering Toufiq Reza has researched sustainable waste-conversion techniques on Earth for years. In Fall 2023, he spent a semester on sabbatical studying at NASA's Kennedy Space Center (KSC). He worked with chemical engineer Annie Meier, who leads a team developing ways to convert astronaut-generated trash into fuel during missions, known as in-situ resource utilization (ISRU).

The sabbatical sparked a new formal partnership between KSC and Florida Tech which will allow both institutions to conduct joint research on logistical waste treatment and ISRU.

AUGUST 2024

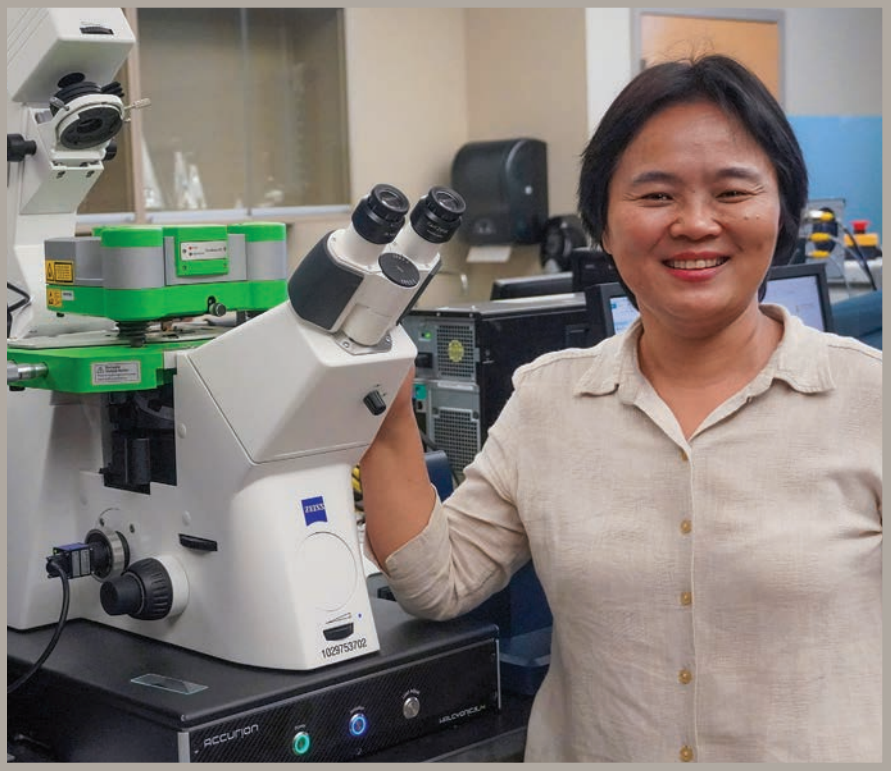
TOTAL AWARDED: **$488,373**
LEAD PI: Andrew Palmer
DEPARTMENT: Ocean Engineering and Marine Sciences
SPONSOR: National Science Foundation
AWARD: Acquisition of a Cryo-enabled Scanning Electron Microscope for Research and Education at the Florida Institute of Technology and Partners

DECEMBER 2024

TOTAL AWARDED: **$434,610**
LEAD PI: Nasri Nesnas
DEPARTMENT: Chemistry and Chemical Engineering
SPONSOR: National Institutes of Health
AWARD: Development of Light Triggered Molecular Tools Cri

APRIL 2024

TOTAL AWARDED: **$429,475**
LEAD PI: Michael King
DEPARTMENT: Harris Institute for Assured Information
SPONSOR: Federal Bureau of Investigation
AWARD: FY24 Automatic Face Recognition Best Practices



RESEARCHER SPOTLIGHT

NAME: **Linxia Gu**

TITLE: Professor of biomedical engineering and science, department head

DEPARTMENT/COLLEGE: Department of Biomedical Engineering and Science/College of Engineering and Science

GENERAL RESEARCH FOCUS: My research focuses on developing physically based computational models and conducting mechanical testing to investigate how mechanical stimuli influence cell and tissue responses, providing new insights into the interplay between mechanics and biology.

CURRENT RESEARCH FUNDING: $5 million as co-PI of ASCEND

What has you EXCITED about your current research?

The opportunity to bridge the gap between mechanics and biology drives my research. By integrating computational models with experimental data, we are uncovering how mechanical forces influence tissue and cellular responses, particularly in the areas of vascular stenting and traumatic injury to the eye and brain. This has the potential to drive breakthroughs in understanding, prevention and treatment.

Why is it IMPORTANT to conduct research?

Conducting research is vital for addressing pressing societal challenges and advancing our understanding of complex biomedical systems. My research emphasizes biomechanics, particularly the interplay between mechanical stimuli and biological responses. Focusing on areas like vascular mechanics and indirect traumatic optic neuropathy, I investigate critical issues such as the structure-function relationships in both healthy and diseased artery and eye tissues, interactions between fluids or blasts and biological tissues, tissue adaptation and remodeling and extreme loading and AI-assisted injury prediction.

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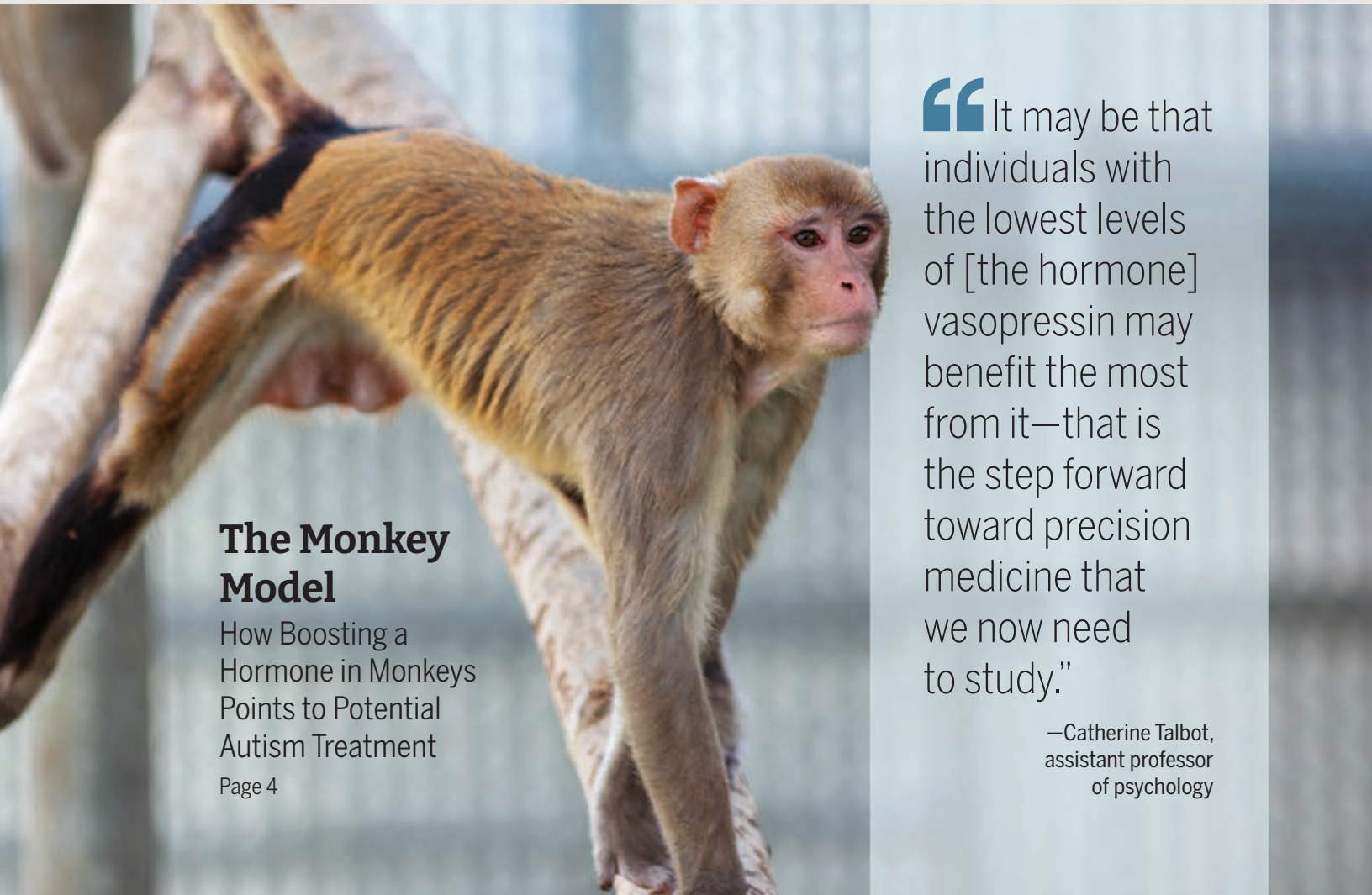

The Monkey Model

How Boosting a Hormone in Monkeys Points to Potential Autism Treatment

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> "It may be that individuals with the lowest levels of [the hormone] vasopressin may benefit the most from it—that is the step forward toward precision medicine that we now need to study."
>
> —Catherine Talbot, assistant professor of psychology