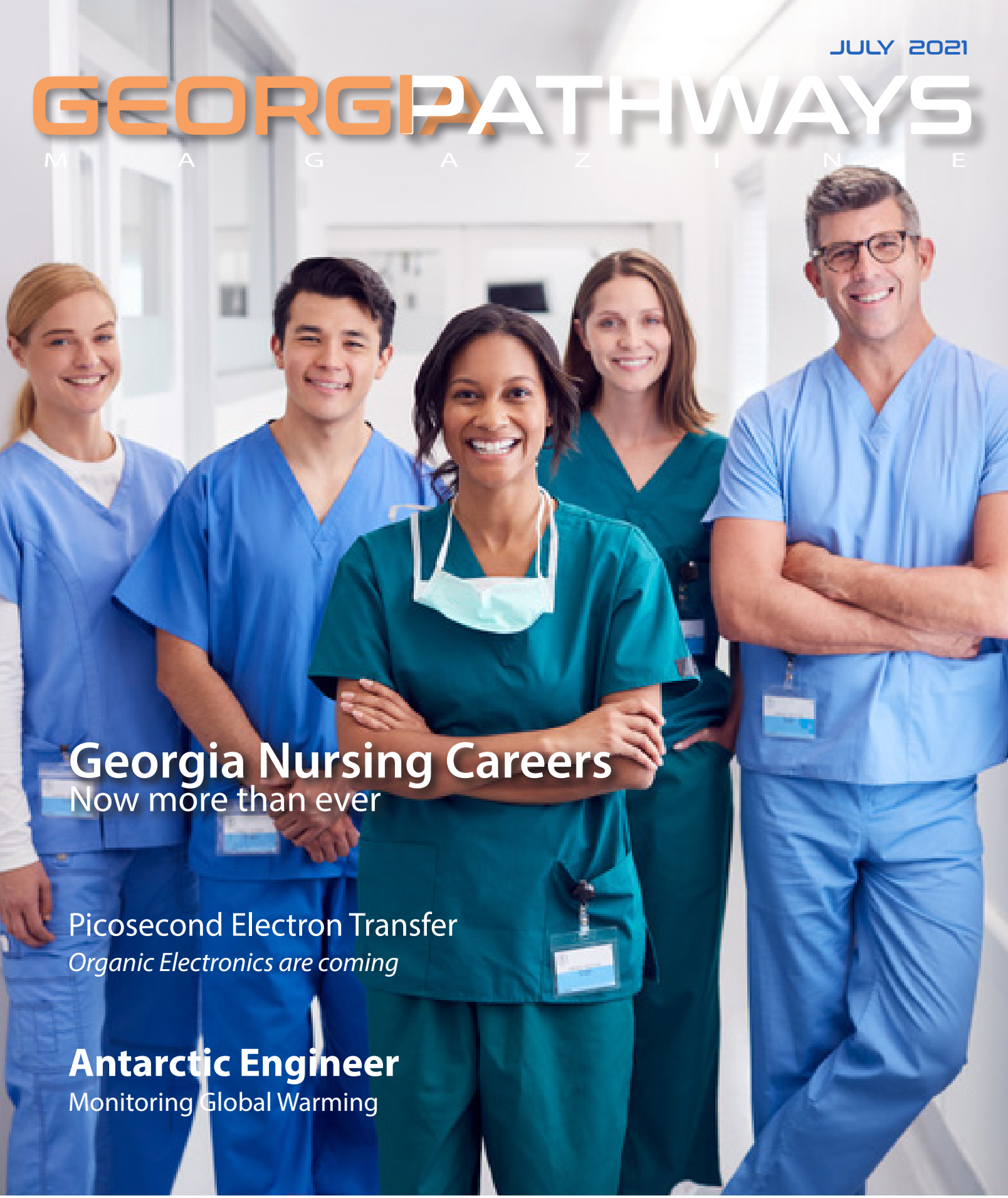
JULY 2021

GEORGIA PATHWAYS MAGAZINE



Georgia Nursing Careers
Now more than ever

Picosecond Electron Transfer
Organic Electronics are coming

Antarctic Engineer
Monitoring Global Warming

TAG Technology Association of Georgia

TAG | TAG-Ed Education Collaborative

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM learning opportunities and connecting them to Technology Association of Georgia (TAG)
resources. Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2000. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEM education in Georgia.

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"Innovation distinguishes between a leader and a follower."

--Steve Jobs

TAG
Technology Association of Georgia

Welcome to the July issue of Georgia Pathways STEM Magazine. The Technology Association of Georgia in June took a big step forward in our quest to fuel the innovation economy. TAG once again was proud to host Fintech South, our signature conference for financial technology.

For three days, Atlanta was the center of the fintech universe. We provided a world-class venue for fintech leaders and innovators around the world to share ideas, network and fuel innovation in this dynamic industry. Although this year's format was virtual, inspiration, education and connections abounded.

At TAG and TAG-Ed, we help members navigate the pressing challenge of building a skilled workforce for the future. To that end, we're committed to providing a variety of STEM and workforce development pathways and educational opportunities. Education is a powerful engine of innovation, and Georgia Pathways STEM Magazine regularly includes content on the importance of careers in technology.

Our July issue is packed with insights on the technology workforce. Here are a few highlights:

- The variety of STEM careers in nursing
- The challenge of music programs coping with the pandemic
- A Georgia State University lab analyzing the impact of the pandemic on Atlanta area students
- An innovative partnership involving Oak Ridge Laboratory to promote STEM Ed.
- Global warming in Antarctica

Every technological career, from banking to robotics, is dependent on the constant accumulation of knowledge through continuing education as our work world changes and grows. By telling compelling stories, STEM skills and the content of Georgia Pathways STEM Magazine help address the ever-changing landscape of our innovation economy and the careers that contribute to its success.

TAG and TAG-Ed would like to thank everyone who participated in Fintech South as well as your continued support of the monthly issues of Georgia Pathways STEM Magazine. Be sure to read and share the latest issue of Georgia Pathways. Your literary contributions are always welcome. Our thanks for your continued interest and support.

Larry K. Williams
President
TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the Technology Association of Georgia (TAG) and President of the TAG Education Collaborative (TAG-Ed). TAG-Ed's mission is to strengthen Georgia's future workforce by providing students with relevant, hands-on STEM learning opportunities by connecting Technology Association of Georgia (TAG) resources with leading STEM education initiatives.

Georgia State University Lab is Analyzing Pandemic-Induced Learning Impacts on Metro-Atlanta Students

By Maggie Reeves

Georgia State University's Metro Atlanta Policy Lab for Education (MAPLE) is conducting rapid-response research with three of its metro-Atlanta school district partners to understand the individual-level learning impacts of the pandemic on students. This rigorous research is intended to inform districts' decision-making, budget planning and remediation strategies.

Georgia State University economist and MAPLE faculty director Tim Sass leads the project. "We are producing the first evidence on the learning impacts of the pandemic on actual students in Georgia, and ours is currently one of only two such multi-district studies to estimate impacts on student achievement in the U.S.," Sass said.

"Understanding the magnitude of effects on student learning will help districts determine which interventions will be sufficient to counteract the losses and what resources will be required."

School districts can use this evidence to target interventions to students with the greatest need. Georgia schools are projected to receive $4.25 billion in funding from the American Rescue Plan Act, some of which can be targeted to these efforts. MAPLE will release its learning impact findings in May.

Following its release, MAPLE will conduct and release additional analyses to understand evidence-based remediation strategies, bright spots, lessons learned and the role of student engagement through the COVID-19 pandemic throughout 2021.

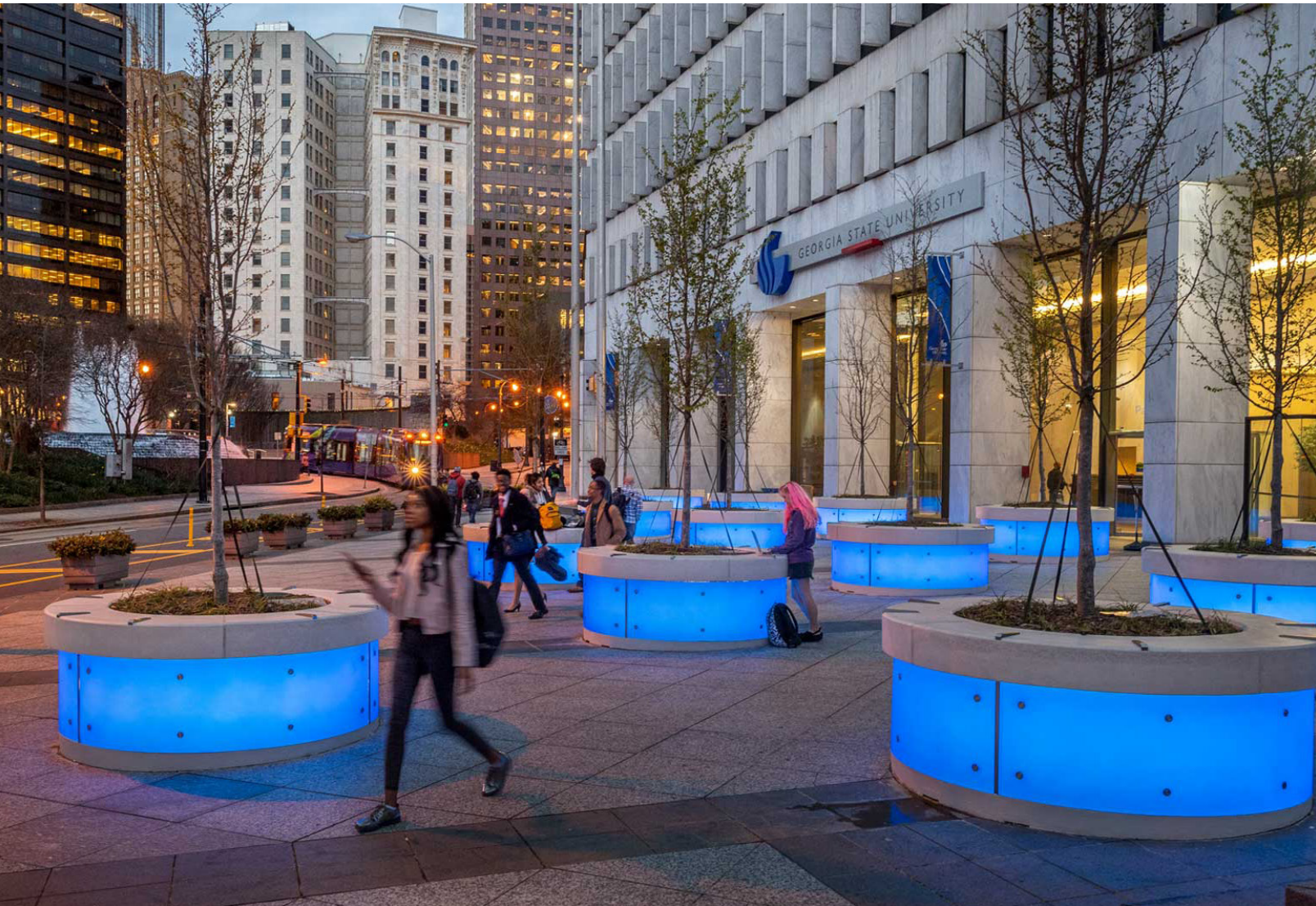
"The goal of MAPLE's comprehensive research strategy is not only to understand which students have been most impacted by school closures and virtual learning but also to understand ways in which school districts can best serve students' academic progress through and past the pandemic," Sass said. "We commend our MAPLE partner districts for their boldness and willingness to embrace an

evidence-based approach that will ultimately help kids who have the greatest needs and are excited that our results are already being used to inform decisions."

MAPLE is one of three research units within the Georgia Policy Labs, which develops mutually beneficial partnerships with government agencies and school districts to generate data-driven insights that inspire public policies that lift children, students, and families—especially those experiencing vulnerabilities.

"The **MAPLE** research-practice partnership (RPP) is unique because it puts our school district partners at the center. These long-term relationships allow us to listen to their most pressing needs and turn around results fast enough for them to inform critical decisions about how to allocate resources and formulate programs to serve those children who need them most to thrive," said Maggie Reeves, GPL's senior director.

Tim Sass is an applied micro-economist whose research focuses on the economics of education. Specific areas of interest include teacher labor supply, the measurement of teacher quality and school choice. He is also the faculty director of the Metro Atlanta Policy Lab for Education in the Georgia Policy Labs. He holds the W.J. Usery Chair of the American Workplace.



Georgia's School Districts Are Overcoming the Band-emic

"School music programs have faced unprecedented challenges over the past year, but some of the state's schools and districts have found ways to break through the silence."

The NAMM Foundation and University of Kansas recognized eight Georgia school districts, which maintained their commitment to music education during the pandemic. "Music education changed perhaps more than any other school subject when learning went virtual" is how the nationally-heard NPR program 1A began a broadcast last month.

During the pandemic, maintaining a sense of "community" in Georgia music programs has been challenging, yet dedicated and creative music teachers, staff administrators and students, supported by a wider community, have succeeded in reinventing music instruction.

The National Association of Music Merchants (NAMM) Foundation celebrated and recognized these school districts:

Baldwin County School District
Clarke County School District
Cobb County School District
DeKalb County School District
Fulton County Schools
Gwinnett County Public Schools
Henry County Board of Education
Putnam County Charter School System

These are among the 686 school districts in 40 states recognized as among the Best Communities for Music Education (BCME) over the past year. Despite schools moving online or to in-person settings where masks were required not only for student musicians but often for instruments, K-12 music teachers have found creative solutions to make music come alive.

"In past years, schools and districts had to work hard to create successful music and arts communities," said Mary Luehrsen, executive director of The NAMM Foundation. "But, never before has the battle been so hard-fought against silence and a feeling of isolation. We applaud with all our hearts the commitment of so many to ensure students continue with deep and rich music learning."

In 2020, as districts shut down for in-person learning, teachers began sending sheet music, videos, and audio to students via the internet. Classes went from the band room to Zoom. Music education became much more individualized and difficult.

"The truth is, music is not meant to be done alone," said Samantha Sarli of the Bristol Public School in Bristol, Conn. "Our students miss their large ensemble experience. Music is very much about the feeling of being in a room with 70 to 90 other students and physically feeling the vibrations, following the conductor and learning where your part fits into the larger picture."

Playing together is possible but hard to manage online. The technology tends to lag and distort the sound. The camera also is a problem for teachers because it generally only shows one angle.

Yet in the schools and districts recognized by The NAMM Foundation this week, dedicated and creative music teachers, supported by a wider community, have succeeded in reinventing music instruction. In so doing, they have brightened the lives of thousands of students, breaking down isolation.

"Countless hours have been spent creating virtual ensemble performance, delivering music to students' houses, repairing instruments on students' front porches, and more," said Allison Rakickas of the Aptakisic-Tripp Community Consolidated School District 102 in Buffalo Grove, Ill.

Breaking out of the routine also has advantages. "I believe that teaching in a hybrid educational system has forced us to think outside the box of what a traditional music performance class is," said Chris Clouthier of the Port Washington Saukville School District in Port Washington, N.Y.

"Teachers are able to teach more in-depth about theory, ear training, and creating music," said April Pickrell of the Santa Fe Public Schools in Santa Fe, N.M. "Many times, teachers are so wrapped up in the next concert that these other skills are not as prominent."

The **science** of music (the systematic accumulation of knowledge), the math of music (The science of numbers and their operations, interrelations, combinations, generalizations, and abstractions [as in musical notation]), and the creative aspects of music (the decision making and problem solving of the engineering method), must be continually taught, reinforced, and put into practice. Teaching and playing music is an extraordinary example of STEM at work.

TumbleWing Glider

“Flies all day”

A cool STEM activity for summer days inside or out.

Nursing

The Vast Georgia Possibilities (*and STEM needs*)

Yes, nursing is a STEM career and there is a growing shortage of nurses, but few are aware of just how diverse the opportunities are in nursing and the wide variety of education levels to meet both your financial and interest levels. It goes without saying that the more education you get, the better the salary and more challenging the career. As always, those choices are up to you.

With hundreds of different nursing specialties available, from helping the new born to caring for the elderly, the science, technology, engineering and math applications provide something for everyone.

Do you want hands on patient care? Done. How about robotic surgery? Do you want to fly? Become an emergency helicopter nurse. Is CSI your thing? Consider forensic nursing and be a crime solver. How about a travel nurse and roam the world working in a different country every few months. Is research for curing disease of interest? Maybe the research lab is for you. Does blood bother you? If not, how about the emergency room or surgery. I could go on for a hundred pages, but I think you get the point.

Jumping into something new is scary when you don't have all of the facts. That's exactly why choosing a career is so challenging. It's not like you can just spend a few years in school, try out a job for a bit and jump to another if you don't like it – well, not without more education and training anyway!

Becoming a nurse is a little different. It's much easier to transition over into a different field once you have the education foundation. We all think we know what an RN does, based on TV shows or our real-life interactions at hospitals or doctor's offices. But what goes on behind the scenes?

You may work with many people of all age groups day in and day out. Sooner or later you'll meet a special patient who will tug on your heartstrings. They're in your care because of illness or possibly even end of life care. Although you want to do everything you can to help him or her, you also have to know when it's time to care for their family.

You need to be a good listener. Nurses are often the ones issuing the orders and making sure patients understand medications or treatment plans, as well as effectively listening and communicating with family members.

So if you want to be an excellent nurse you'll need to be an excellent listener, too.

Experts say that by listening you can learn a lot – and there's always more for nurses to learn! Listening to patients is crucial for determining the best way to care for them. Paying close attention can also help shed light on important medical conclusions. And of course, the patients will appreciate feeling heard.

Your skills can take you many places. You learn many new skills while earning your nursing credentials and some of them transferable skills that can help if you decide to move on into another specialty or career field. Nurses aren't limited to working in hospitals and they're not even limited to just caring for patients! Teaching, tutoring and recruiting are other viable job options former nurses can pursue.

STEM skills that every nurse needs are knowledge (the science), the use of special medical computer software and instruments (the technology), life saving decision making on a daily basis (the engineering method), and a wide variety of simple and sometimes complicated (math) applications such as filling a syringe with the proper amount of medication, adjusting machines to the proper settings numerically, timing and carting for accurate patient care, taking blood pressures and temperatures which require basic math.

Then there are complicated lab formulas that require advanced algebra, physics, and beyond to determine medication effectiveness, drug interactions, risk assessment and experimental research. You'll also need the "A" in STEAM (language arts) for gaining clinical knowledge, academic writing, time management, process, procedures, instructions and leadership skills.

Most nurses don't go into the profession with the idea that they'll be rich. Of course, most people don't work for free, either. But we all hope your main motivation for becoming a nurse is to care for those in need. Once again, your salary will depend on your motivation to gain the knowledge necessary for those very high paying jobs. If you have the passion to help others, you will be rewarded. Nursing schools and nursing education is very flexible so let's look at the basics:

CNA: certified nursing assistant
Degree level: high school diploma
Mean salary: $35,208

As its title suggests, CNAs assist nurses with patient admittance and vitals. It is the lowest level credential that one can have in the nursing field and it does not make a person a nurse. CNAs are required to pass a specialized exam to work in the field but it is typically only tied to a single course so there is a quicker point of entry.

LPN: licensed practical nurse Degree level: diploma/associate Mean salary: $42,557

Becoming an LPN requires either an associate degree (2 year) or a diploma and can be accomplished in as little as 12 months. After completing a program from an accredited school, LPNs sit for the National Council Licensure Exam (NCLEX-PN) to become certified.

Many LPNs work in clinics or private home settings and are responsible for registering patient vital signs such as heart rate and blood pressure, collecting blood samples and feeding, dressing, and caring for patients.

LPN tracks are often the first choice of people who want to begin a career as a nurse but do not have time to commit to a longer program right away.

LVN: licensed vocational nurse
Degree level: diploma/associate
Mean salary: $42,640

LVNs have identical positions to LPNs. The only difference is that the term "vocational nurse" is the title used in California and Texas. Like LPNs they complete an associate or diploma degree program and must pass the NCLEX for certification.

RN: registered nurse
Degree level: associate/bachelor's
Mean salary: $64,886

RNs, or professional nurses, are the most in-demand positions in the U.S. An RN credential is either earned through an associate or bachelor's degree. There are also opportunities for LPNs to continue their education and earn an RN credential through a mobility program. RNs are certified through the NCLEX-RN examination which contains higher level nursing topics than the LPN version.

The increased training gives RNs the tools to be responsible for more holistic care of patients from beginning to end of their treatment and allows them to work in a variety of settings from hospitals to critical care. This level of education has the greatest potential and flexibility so far in our review.

BSN: Bachelor of Science in nursing
Degree level: bachelor's
Mean salary: $73,091

A BSN is a registered nurse that has earned a bachelor's degree. Nurses attain their bachelor degree through a traditional four-year program at a university or continue their education from an existing RN associates degree through a completer program in as little as 12 additional months. The American Association of Colleges of Nursing has called for 80 percent of nurses in hospitals to hold a bachelor degree by 2022.

The additional educational credits can open the door to the 370,000 + jobs in the last 12 months alone that all preferred to hire someone with a BSN.

MSN: Master of Science in nursing
Degree level: master's
Mean salary: $73,768

The most common graduate-level degree in nursing is MSN but there are several variations including Master of Nursing (MN) and Master of Science (MS) or Master of Arts (MA) with a major in nursing. As with any profession, you can continue to open career opportunities by bolstering your nursing degree with additional education.

One option for MSNs is becoming a nurse educator since most state nursing boards require the faculty to have at least one credential higher than the level of the program they are teaching.

CRNA: certified registered nurse anesthetist
Degree level: master's/doctorate
Mean salary: $157,000 - $214,000

The CRNA is a graduate-level certification that nurses are eligible to pursue after completing a BSN program. Accredited CRNA programs culminate in either a master's degree or doctorate with the opportunity to sit for a national certification exam. Nurse anesthetists are compensated highly for bearing the heavy responsibility of putting patients under anesthesia prior to surgery.

CNM: certified nurse-midwife
Degree level: master's
Mean salary: $70,000

CNMs, also referred to as certified midwives (CMs), are registered nurses that hold a master's degree and work with women through pregnancy, childbirth and postpartum. There is a national certification exam at the end of the program to designate the skill of midwifery.

COHN: certified occupational health nurse
Degree level: master's/doctorate
Mean salary: $63,472

Occupational health nurses (OHNs) work with companies to create a safe work environment for employees. The COHN is another graduate-level certification for registered nurses with a BSN. Depending upon the program, COHN programs can lead to either a master's or doctorate degree and culminate with a certification exam.

NP: nurse practitioner
Degree level: master's/doctorate
Salary range: $90,583

NPs are registered nurses with a graduate-level degree, sometimes also referred to as advanced practice registered nurses (APRN). NPs are one of the main positions that hospitals are hoping to lean on to help alleviate the shortage of doctors that is expected in the very near future.

NR: nurse researcher
Degree level: doctorate
Salary range: $95,000 - $100,000

Nurse researchers are doctoral-prepared registered nurses that followed a scientific path of nursing. After completing a bachelor's and master's degree they either pursue a Doctor of Philosophy (PhD) in a nursing-related subject or a Doctor of Nursing Science (DNS). These nurses work side-by-side with other scientists to study illnesses and other healthcare initiatives.

Very few careers offer such a diverse choice of education levels and specialty opportunities. You should look at this one long and hard. Knowing what to expect in nursing school can help you be prepared for what's to come. You'll never stop learning.

- Neuroscience Nurse (the brain)
- Occupational Health Nurse
- Oncology Nurse (cancer)
- Ophthalmic Nurse (eyes)
- Operating Room Nurse
- Orthopedic Nurse (bones and joints)
- Otorhinolaryngology Nurse (ear, nose and throat)
- Pediatric Nurse (children and teens)
- Perianesthesia Nurse (recovering from anesthesia)

- Ambulatory Care Nurse (outside the hospital care)
- Cardiac Rehabilitation Nurse (the heart)
- Case Management
- Correctional Nurse
- Enterostomal Therapy Nurse (Urinary conditions)
- Gastroenterology/Endoscopy Nurse (looking at your guts)
- Genetics Nurse
- Infection Control Nurse
- Intravenous Therapy Nurse (veins)
- Long-Term Care Nurse
- Managed Care Nurse
- Nephrology Nurse (kidneys)
- Perinatal Nurse (cares for women during pregnancy, birth and after)
- Primary Care/Office Nurse
- Psychiatric Nurse
- Re-constructive Surgical Nurse
- Rehabilitation Nurse
- Respiratory Nurse (breathing)
- School Nurse
- Case Management
- Correctional Nurse
- Enterostomal Therapy Nurse (Urinary conditions)
- Gastroenterology/Endoscopy Nurse (looking at your guts)
- **The list goes on...**


“All you need is the vision and passion,
now more than ever”

AdvancedMD

5 Things You Need to Know to Successfully Manage a Team

By Amanda Hansen
President of Advanced MD

In order to successfully manage a team, leaders need to remember the word "manage" is a verb. And more than that, it's an action verb. Management is not supposed to be a passive experience or title one earns with tenure. There is no magic managerial dust you can sprinkle over a group of people to turn them into a successful, trusting, and competent team.

It takes work, intention, and active leadership.

In 2019, when I was named president of AdvancedMD, a cloud-based suite of software solutions designed for independent physicians, I made it my personal mission for the company to be a place where people want to work, rather than a place where people simply go to work. I firmly believe a company is only as good as its people, and if we want to excel for our customers, we must have employees that excel.

Here are five areas I focus on relentlessly in order to successfully manage teams:

1. Create a Remarkable Culture

Many years ago, while serving a mission for the LDS church, I lived in Mongolia and learned the cultural expression, "nadad chukhal gedgee medrüüleerei," which translates to "make me feel important." In Mongolia, this isn't just a thoughtful adage — it's a way of life. Because when you make people feel important, you've met

their greatest emotional need — to feel accepted. Making people feel important is rooted in the culture AdvancedMD, and because of it, employees are inspired and motivated.

It's important to note that culture isn't a given. Managers must consistently and diligently work on it and strive to keep it exceptional. And, once you've built a great cultural foundation, it's critical to address any threats — a toxic employee, staff turnover, or burnout — in real time. Hold people accountable and be clear on what you will and won't tolerate. It takes years to build a great culture, and it can crumble in an instant.

2. Empower Employees

Nothing stifles productivity like being entangled in a proverbial ball of red tape. When employees feel like they lack the authority or resources to reach their potential, they disengage. But when they're empowered to find solutions and keep going, they do. Employees who feel supported and encouraged are not only more motivated and creative, they're also likely to be more loyal and committed to the company. Even better, empowerment is contagious. Empowered people empower people.

3. Train & Develop Talent

Training employees is so much more than handing them an onboarding document on their first day and telling them, "Godspeed." Because best practices and industry standards evolve, training should be a continuous process. Beyond the basics of how to perform a specific job, proper training and professional development increases employee engagement, productivity, retention, and ultimately company revenue. Employees who are trained and offered opportunities for professional development feel invested in by their company, which makes them more loyal in return. It also gives managers an opportunity to identify unknown skills an employee might have and address any weaknesses.

4. Recognize Greatness

The old school of thought, and one some managers still embrace, goes something like this: "I do recognize my employees. Every two weeks. It's called a paycheck." Not only is this an incredibly dated concept, it's also potentially damaging to employee morale and retention. Human beings are hardwired for praise. Recognition is the cornerstone of our self-esteem.

When we feel valued and appreciated, when our work is acknowledged, it motivates us and provides us with a sense of accomplishment. Employees who receive validation from their managers understand their value to the company and how they contribute to success.

Of course, recognition shouldn't be doled out just because, employees should earn it. But as managers, it's incumbent upon us to look for contributions we can recognize and offer our sincere appreciation and adulation.

5. Embrace Transparency

If you want employees who believe in the company's future and who trust their managers to do the right thing, transparency is vital. This might mean managers have to dismantle the "hierarchy of communication status quo" and build a new pipeline to ensure strategic decisions aren't kept a secret. No employee should ever be told of a new policy and wonder, "Why are we doing this?" Let your team know you respect and value their input by asking them for it before making decisions that will impact them. Keep in mind, transparency isn't limited to corporate processes. It also involves honest and frequent feedback about performance. As an added bonus, I've found transparency not only builds trust, it removes barriers to innovation as well.

Amanda Hansen is the president of AdvancedMD. Throughout her tenure with the company, she has held multiple positions in business development, sales, service, finance, and strategy. She also played a critical role in Global Payments' recent $700 million acquisition of AdvancedMD from Marlin Equity Partners.

Amanda is passionate about increasing operational effectiveness and profitability and driving continual growth while improving patient care and access to healthcare through innovative software solutions. Hansen's competitive edge, positive outlook, and solution-oriented approach have made a noticeable impact on the vision, direction, and achievements of Advanced MD.

Amanda is fluent in Mongolian and enjoys mountain biking, snowboarding, observing and playing all sports, and spending time with her three children. Amanda has a bachelor's degree in communication from Brigham Young University.

Amanda Hansen

"How will Senior Adults Define my Career Choice?"

By **Dale Keshishian**
Founder and CEO of HealthWorks Academies

As many people do, I was lucky enough to have a very close relationship with my grandmother. When I was a little girl, I would stay at her house every Saturday night. It was a tradition for us to stay up late and watch movies on television, something I wasn't allowed to do at home.

When I was coming over, she would go out and buy my favorite caramel popcorn for us to eat while watching our favorite programs. She was a creative, funny and truly inspiring woman, and I loved her very much. For as long as I can remember, my grandmother suffered from asthma. I remember feeling so helpless when she got sick and it became unbearable to watch her struggle just to breathe.

The day after I got my driver's license, she called in the middle of the night and asked me to take her to the hospital because her inability to breath had gotten so severe.

Thinking back on this part of my life, I often wonder if she is the reason I have spent my career in healthcare. By 2022, this country will have 74 million seniors. Ten thousand people turn 65 each day, and that rate is expected to continue through the year 2030! In today's age, people are living longer than at any time in history, so the percentage of the population over the age of 65 will continue to expand.

The needs of seniors and the demand this places on the healthcare system are dramatic. It means we will need many more healthcare professionals in traditional roles, particularly as the healthcare workforce ages. We will see emerging careers as well, as the industry transforms to satisfy the demand of the seniors and improve health outcomes.

Clinical pharmacists, professionals who expand the capabilities of physicians to help patients manage multiple medications for many different medical conditions, will be in great demand. More nurse practitioners and physician assistants will be needed as well as specialists in geriatric medicine. Nutritionists, physical therapists and diabetic nurse educators will also be in demand as the population ages and chronic disease like diabetes continue to rise.

When we consider the needs of seniors, and the sheer numbers we'll be facing as a nation, we must also consider that we will have to do some things differently. Housing, transportation and assistance with daily living will undergo dramatic change. Home care professionals will be certified with a career ladder and will be active participants in the healthcare team. Maintaining individuals in their homes and as independent as possible will be critically important. The cost of institutional care is roughly double compared to providing services and keeping seniors at home, where they want to be. We can anticipate an explosion of technology to assist seniors to remain independent, manage medication and stay safe at home.

Professionals will need to monitor and maintain technology. We'll also need people to analyze and report data to constantly improve services.

If there is ever a time to be excited about a STEM profession, this is it! There are so many opportunities to match interest with market demands. Careers that serve to meet the needs of seniors and help them live healthy, independent, active lives will provide a long, successful and satisfying career.

Nursing is a GREAT STEM Career

Picosecond Electron Transfer In Peptides can help energy technologies

By Holly Ober

Biological energy flows, such as in photosynthesis and respiration, depend on the transfer of electrons from one molecule to another. Despite its importance to sustaining life, factors governing the rate of electron transfer, especially over long distances, are not well understood because the systems that mediate such ultrafast processes are very complex. A better understanding of electron transfer rates would help scientists improve chemical transformations, energy conversion, electronic devices, and photonic technologies.

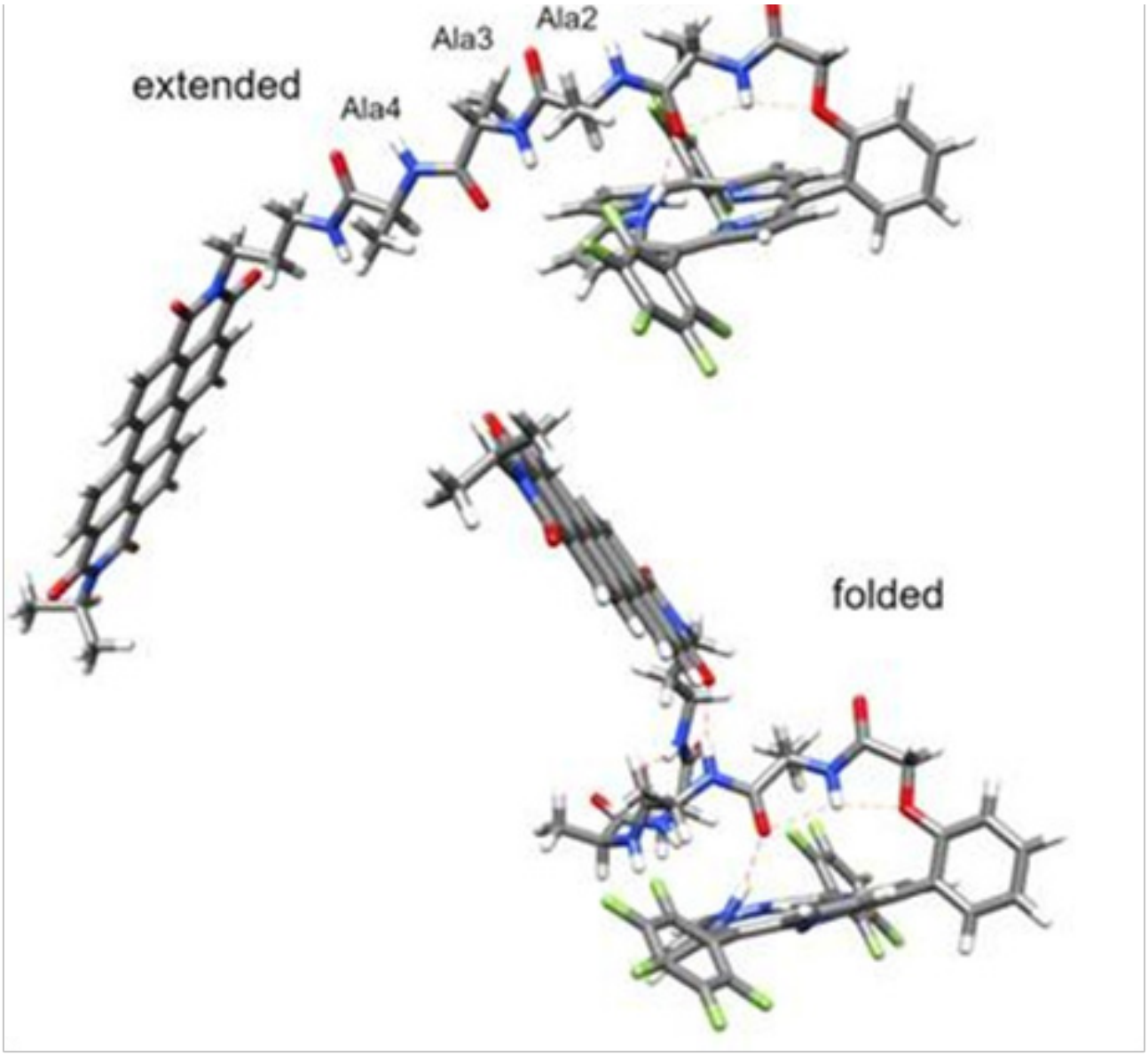
Now, an international team of researchers led by UC Riverside has observed picosecond charge transfer mediated by hydrogen bonds in peptides. A picosecond is one trillionth of a second. As short-chain analogs of proteins, crucially important building blocks of living organisms, peptides are chains of chemically linked amino acids. The discovery shows the role of hydrogen bonds in electron transfer. The results are published in Proceedings of the National Academy of Sciences.

pic·o·sec·ond

/pēkō,sek(ə)nd, ’pīkō,sek(ə)nd/
noun
noun: picosecond; plural noun: picoseconds; noun: pico-second; plural noun: pico-seconds; symbol: ps

- one trillionth of a second.

A picosecond is an SI unit of time equal to 10^{-12} or $^{1}/_{1\,000\,000\,000}$ of a second. That is one trillionth, or one millionth of one millionth of a second, or 0.000 000 000 001 seconds. A picosecond is to one second as one second is to approximately 31,689 years.



The extended peptide (top) does not mediate charge transfer (detectable charge transfer)/ The folded peptide (bottom) mediates picosecond charge transfer along the hydrogen bonds between the donor and the acceptor (the hydrogen bonds are indicated with thin red dotted lines). (Valentine Vullev)

Valentine Vullev, a professor of bioengineering at UC Riverside's Marlan and Rosemary Bourns College of Engineering, along with Daniel Gryko from the Polish Academy of Sciences, and Harry Gray from the California Institute of Technology, led a team that discovered unusually ultrafast electron transfer from a donor to an acceptor molecule connected with oligopeptide linkers stretching up to 20 covalent bonds.

Electron transfer usually takes a microsecond, or one millionth of a second, in peptides with such long through-bond distances.

The researchers were surprised to observe picosecond electron transfer, a rate 1 million times faster than previously known for such systems.

"*It shouldn't work, but it does*," Vullev

said. "*The picosecond charge transfer we observed contradicts structural biology, assuming the expected random distribution of structures of the flexible peptide chains.*"

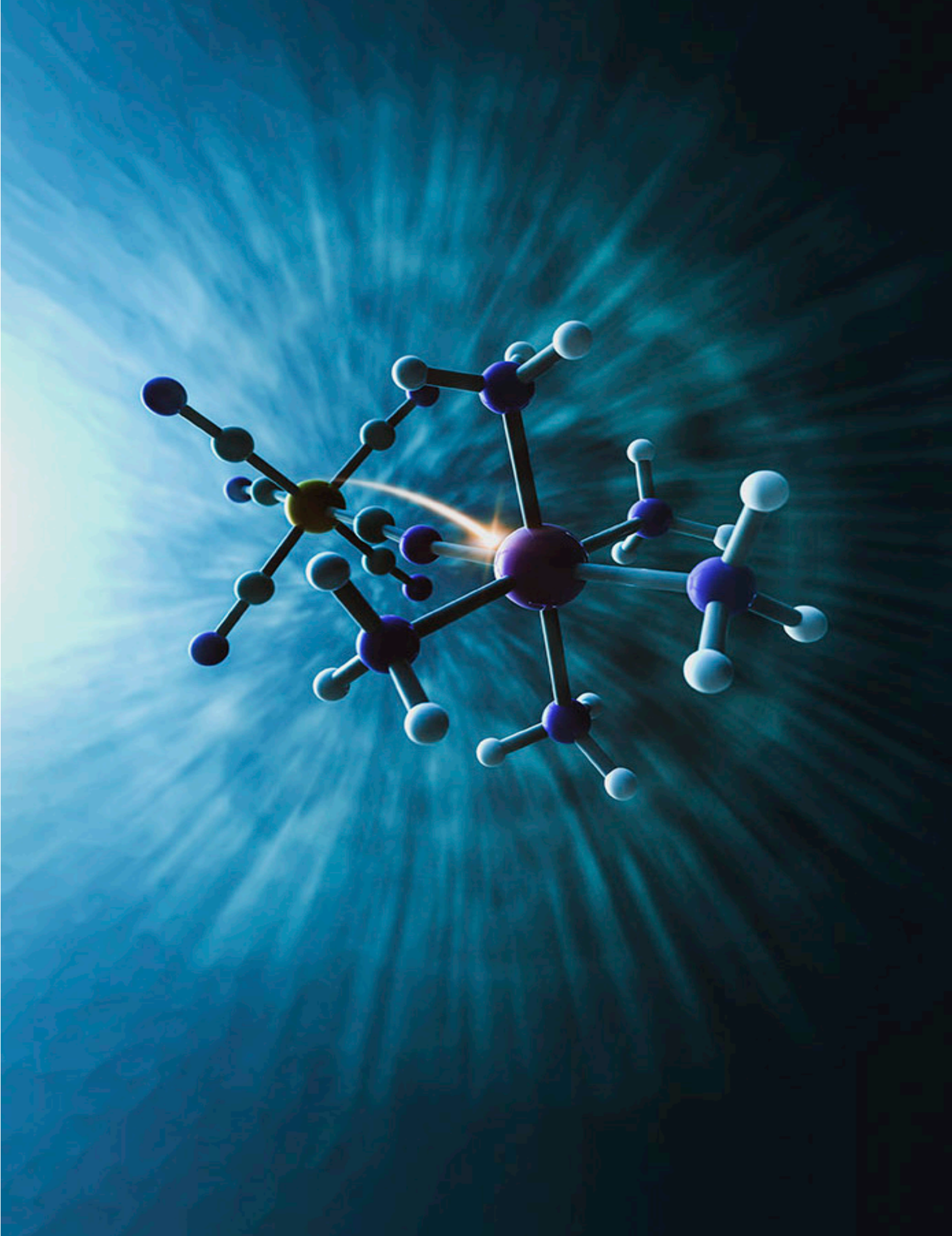
The team chose donor and receptor molecules linked by short peptides they discovered actually assume well-defined structures stabilized by hydrogen bonds. Further analysis revealed that hydrogen bonds within each molecule brought the donor and acceptor close to each other in a scorpion-shaped molecular architecture, enabling picosecond electron transfer.

"This revolutionary design demonstrates short peptides can not only assume well-defined secondary conformations when templated by organic components but also provide a hydrogen-bonding network that can mediate electron transfer with unusually high efficiencies," Vullev said. "Our work provides unprecedented paradigms for the design and development of charge-transfer pathways along flexible bridges, as well as insights into structural motifs for mediating electron transfer in proteins."

The findings could lead to advances in energy storage as well as spur development of organic electronics that use conducting polymers instead of conducting minerals. "One of the most exciting and fulfilling aspects about working in our group is being at the forefront of such discoveries and observing these spectacular results," said co-author John Clark, a doctoral student in Vullev's lab who did photochemical measurements for the research.

The paper, "Role of intramolecular hydrogen bonds in promoting electron flow through amino acid and oligopeptide conjugates," is available - https://www.pnas.org/content/118/11/e2026462118

Other authors include Rafał Orłowski, Olga Staszewska-Krajewska, Hanna Jedrzejewska, and Agnieszka Szumna at the Polish Academy of Sciences; John A. Clark, James B. Derr, Eli M. Espinoza, and Maximilian F. Mayther at UC Riverside; and Jay R. Winkler at the California Institute of Technology.



ORNL Partners On Science Kits For STEM Schools

By Karen K Dunlap / ORNL

Oak Ridge National Laboratory, the U.S. Department of Energy, the Center of Science and Industry and the Tennessee STEM Innovation Network have partnered to deliver hundreds of free science kits called Learning Lunchboxes to STEM-designated schools in East Tennessee. The program, named the Tennessee Distance Learning Initiative, provides engaging, hands-on activities aligned with Next Generation Science Standards.

ORNL Director Thomas Zacharia and Associate Laboratory Director Stan Wullschleger visited classrooms at Midway Elementary School in Kingston, Tennessee, on Friday as teachers led students through an activity from the energy-themed box. Frederic Bertley, president and CEO of COSI, and Stephen White, COSI vice president of external affairs, strategic initiatives and business development, also attended.

"Supporting the next generation of STEM talent means reaching students who may lack access to digital resources," said Zacharia. "This innovative partnership demonstrates our commitment to engage and inspire our community's youth in science and engineering fields."

The kits contain directions and materials for five activities that explore energy sources, such as building a solar oven or a wind-powered vehicle. An ORNL-themed activity explains and demonstrates how supercomputers work through the power of parallel processing.

"We're on a mission to save the planet, and STEM skills are key to getting this done," said AnneMarie Horowitz, director of DOE's STEM Rising. "This type of public/private partnership demonstrates how we can come together to serve students and families. The U.S. Department of Energy thanks COSI and Oak Ridge National Lab for working collaboratively to showcase the importance of STEM."
In addition to Midway Elementary, this initial round of Learning Lunchboxes also

will be delivered to Oliver Springs High School, Midway Middle School and Elk Valley STEM School.

COSI, a science learning center based in Columbus, Ohio, has distributed more than 23,000 Learning Lunchbox kits to students and families across Ohio prior to this week's launch in Tennessee. "This pandemic has amplified an educational disparity in our communities. It is great to have government, for-profit and nonprofit institutions alike working better together to help ameliorate educational outcomes for our classrooms and communities," said Bertley.

DOE's STEM Rising initiative inspires, educates and sparks lifelong success in STEM by sharing resources and events from the national labs, the National Nuclear Security Administration and DOE program offices.

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Monitoring Global Warming - What It Takes to Be an Antarctic Engineer

Jim O'Sullivan and Julius Rix demonstrate the essential qualities of resourcefulness and endurance

By Lucas Laursen

There is no visible horizon in the waters beneath the Ross Ice Shelf. So electrical engineer Jim O'Sullivan built an artificial one for the pilot of the submersible remotely operated vehicle (ROV) that he and a team of scientists were testing there in 2008.

The team didn't lack for data: The ROV's orientation, speed, and depth were numerically displayed on the pilot's screen. But it is difficult to convert numbers into spatial awareness. The ROV was at risk of crashing into

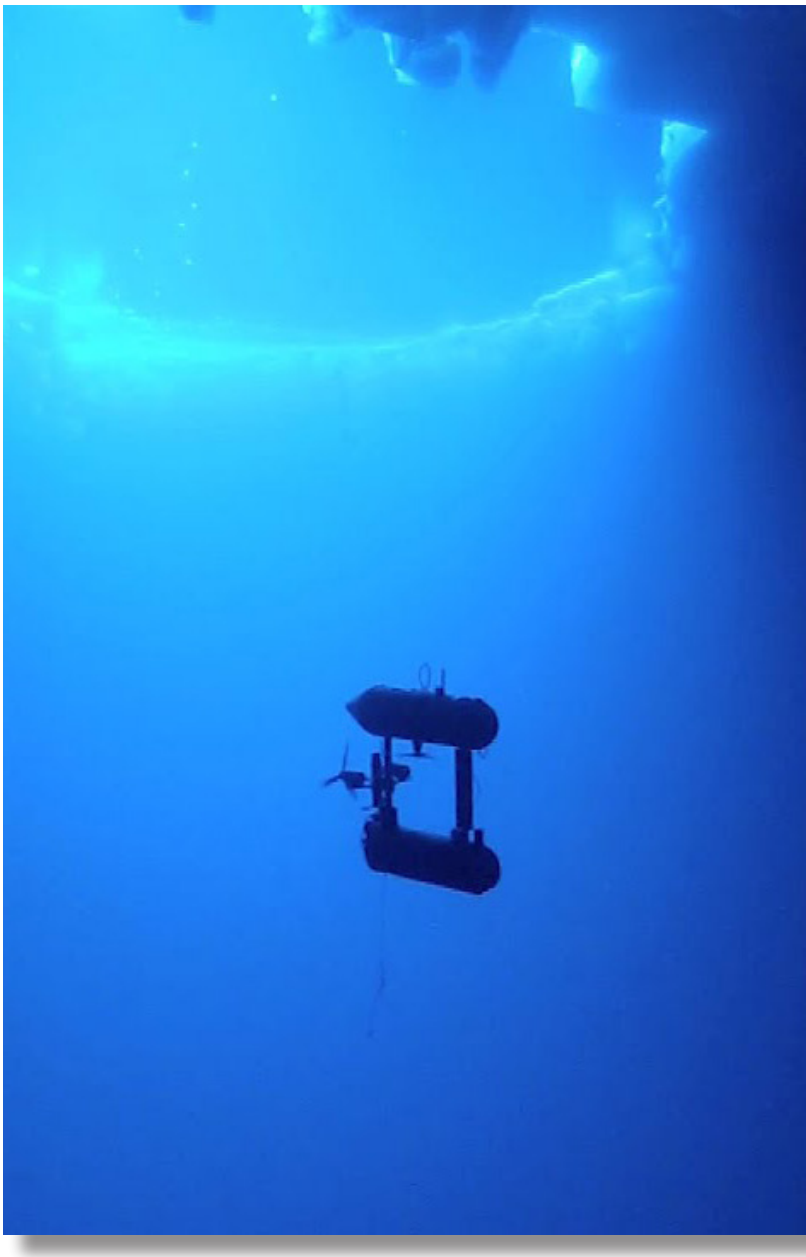
the delicate creatures, such as sea spiders, that it was supposed to be observing.

Fortunately, O'Sullivan had come across a similar problem in a different setting: aviation. As a pilot, he had an instrument rating, "which was useful for understanding how to navigate without being able to see," he recalls. When flying blind, pilots use half a dozen different instruments to maintain their situational awareness, including an artificial horizon.

O'Sullivan found open-source software that could convert the ROV's telemetry data to display an artificial, underwater horizon. This example of engineering on (and under) "the Ice,"—as Antarctica is known—demonstrates the need for ingenuity and improvisation beyond anything training can provide.

In fact, those characteristics are precisely how British Antarctic Survey (BAS) engineer Julius Rix got his job: "My boss told me I got my first job with him because of my hobby working on old cars," Rix says. Unlike O'Sullivan, who went to Antarctica as a contract engineer for a one-time gig and now advises startups in and around Palo Alto, Calif., Rix has grown increasingly involved in Antarctic engineering.

Rix got that first job maintaining ionosphere-measuring equipment at Halley Research Station on the Brunt Ice Shelf in 2008 after doing a Ph.D. in vehicle dynamics.



After two years, he took a medical-imaging job in the United Kingdom. But his old boss lured him back a few years later to move the equipment from the old Halley station to a new one. Now he is a staff engineer at the BAS Cambridge office and has returned to Antarctica twice with a scientific team searching for the world's oldest ice and to monitor the melt.

At Rix's Cambridge office, a tangle of hats, gloves, goggles, and giant fuzzy boots nearby attest to his frequent visits to a nearby walk-in freezer, with ice core samples and drilling equipment. In between visits to Antarctica, Rix must troubleshoot the drilling equipment and try to anticipate what might go wrong in the field, packing accordingly.

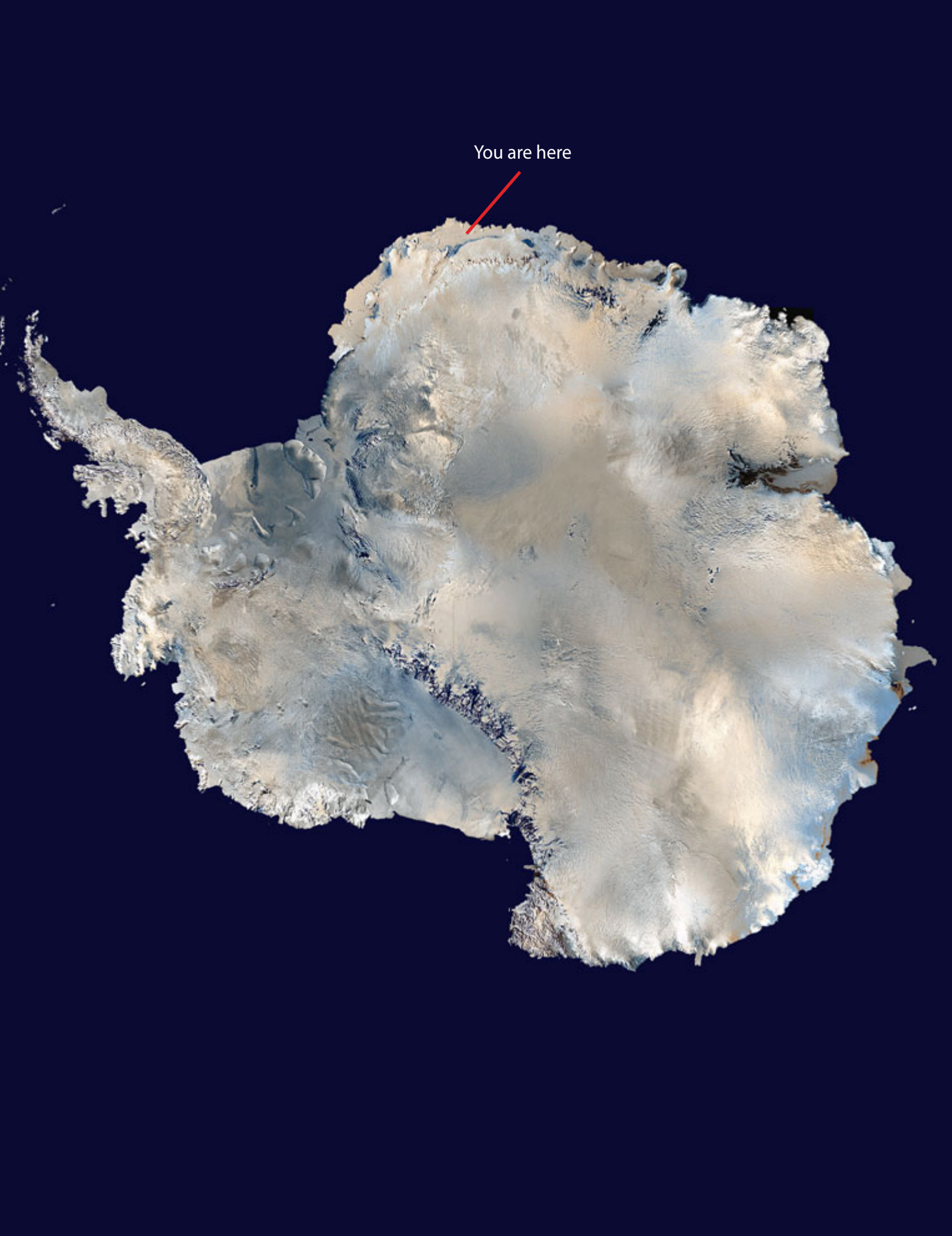
Still, teams are unlikely to anticipate everything and must be prepared to adapt. "Learn as many skills as you can," he advises prospective Antarctic engineers. Recent job ads for electrical or electronics engineering jobs in Antarctica confirm that while jobs are available for those seeking an unusual workplace, a diversity of experience and willingness to embrace difficult living conditions are prerequisites.

Engineers on the Ice do everything from building new facilities to maintaining telescopes and tagging along with scientific teams for temporary projects, as O'Sullivan did.

The diversity of roles means that many kinds of engineers can go, but be warned: The competition is stiff.

Several nations operate Antarctic research programs. Interested applicants should monitor these programs' websites and those of any private contractors supporting national programs. Hiring tends to be seasonal: Opportunities spike for the Antarctic summer. Another method is to seek out scientific research projects that may need an engineer and approach them directly. O'Sullivan got his field gig through an introduction from a mutual contact.

Both O'Sullivan and Rix emphasize the difficulties that come from Antarctica's remoteness. "Probably the isolation was the hardest part," O'Sullivan says. That goes for digital communication almost as much as physical isolation: Few satellites dip that far south, and visitors must be prepared for limited Internet bandwidth. Rix noted that his wife didn't like his being away so long and the uncertainty of when or if he would return.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