VIRGINIA TECH

ENGINEER

Virginia Tech College of Engineering | Winter 2019

THE FUTURE OF FARMING

Virginia Tech researchers are laying the groundwork for an accessible future of agriculture.

THE SCENE

Preparing for takeoff

Doctoral candidates Kevin Yu and Yoonchang Sung work with senior undergraduate Tianshu Xu and master of science student Deeksha Dixit on the aerial and ground vehicles that the electrical and computer engineering students aim to make cooperative and able to autonomously monitor agricultural land. The research is led by assistant professor Pratap Tokekar, an expert in cooperative autonomous systems.

Photo: Peter Means

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Jonathan Boreyko (left) and Brook Kennedy set-up a full-scale fog harp prototype at Blacksburg's Heritage Community Park.

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COVER: Researchers from the lab of electrical and computer engineering assistant professor Pratap Tokekar test aerial and ground vehicles at Virginia Tech's Kentland Farm. Photo by Peter Means

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Shaping global leaders of tomorrow

Dear Alumni and Friends,

It is my privilege to share with you the inaugural print edition of the *Virginia Tech Engineer*, which provides a glimpse of what is happening in our college and in our network of faculty, staff, students, friends, and alumni.

For almost 150 years, the Virginia Tech College of Engineering has been conducting life-changing research and educating the leaders of tomorrow. Our faculty and students continue to work together, with colleagues from other disciplines, partnering with universities, and around the globe to solve critical challenges.

As the fifth largest producer of engineers in the nation, the college has a unique opportunity to help fuel the pipeline of a globally astute workforce and academic leaders. We are relentlessly imagining ways to disrupt technology and improve life on this planet and our faculty and staff remain dedicated to our creative, innovative students who push these boundaries every day.

We celebrate the *U.S. News & World Report*'s annual *Best Engineering School* survey, which ranks the college's undergraduate program No.13 nationally, up one spot from last year. The college is historically known for its strong theoretical and fundamental foundation learned in the classroom and applied through hands-on experiences, co-ops and internships, undergraduate research, and study abroad. We continue to be sought after by the best and brightest future engineers, seeing a 20 percent increase in applications this academic year.

I am excited about the creation of Virginia Tech's Innovation Campus, a $1 million-square-foot campus located less than two miles from Amazon's new location in Alexandria, Virginia. As a result, we will also see tremendous growth on the Blacksburg campus, expand partnerships with industry, and be able provide more experiential learning opportunities for our students.

We are forever grateful to our alumni and friends for the continuing support that provides for state-of-the-art facilities, experiential learning for students, research breakthroughs, and much more. With your generosity we can propel the college forward.

Warm regards,

Julia M. Ross
Paul and Dorothea Torgersen Dean of Engineering

Photo: Logan Wallace

The woman bringing Virginia Tech's power electronics to D.C.

Christina DiMarino looked to be a prime candidate for the Center for Power Electronics. There was only one problem. by ERICA CORDER

National Academy of Engineering member Dushan Boroyevich made a point of sitting next to Christina DiMarino during a dinner in spring 2012.

As the then co-director of the Center for Power Electronics Systems (CPES), Boroyevich was on a recruitment mission. He saw promise in DiMarino, who'd been offered a competitive Webber Fellowship to study at Virginia Tech.

There was only one problem: DiMarino didn't know what power electronics was.

"I came for recruitment weekend and got to visit a bunch of labs," DiMarino said. "But actually CPES was not one of the labs that I chose to visit ... which, apparently, was a mistake."

Recruitment weekend allowed her to explore options for her upcoming studies through Virginia Tech's direct Ph.D. program, which allowed her to move straight from her general engineering undergraduate degree at James Madison University into her doctorate studies in electrical engineering at Virginia Tech.

"The last event for that recruitment weekend was a dinner and Dushan sat right next to me and asked, 'are you Christina?' I said yes, and he said, 'did you tour CPES?' I said no," DiMarino recalled. "And he said, 'Ok, after dinner, you're going to come tour the lab.'"

> "I just knew whatever power electronics was, I needed to learn very quickly and get in that field." —Christina DiMarino, Assistant Director of CPES

The pair walked to Whittemore Hall, where the center occupies the majority of the first floor and has room for more than 50 graduate student workspaces.

In showing her the internationally renowned center's research projects, Boroyevich gave DiMarino a crash course in power electronics—an omnipresent field, considering its findings improve the efficiency of electronically powered devices, such as cell phones, electric vehicles, and solar panels for a home. DiMarino instantly saw how expansive the field already was, with further growth on the horizon in an increasingly electric-powered world.

"I just knew whatever power electronics was, I needed to learn very quickly and get in that field," DiMarino said.

Now, a few years later, DiMarino is the assistant director of CPES under Boroyevich's directorship and a faculty member since finishing up her Ph.D.

But she isn't working in Blacksburg. In fact, DiMarino has been working for more than a year on building a presence for CPES in Northern Virginia at the Virginia Tech Research Center in Arlington, starting with a lab that opened in late September 2018.

The new lab will hold about 10 more graduate students and will collaborate on projects across both campuses. In the future, DiMarino says, there's a conversation to be had about moving certain projects specifically to the Arlington lab, considering many of their government and industry funding agencies are in close proximity.

DiMarino already has her sights set on growth—but she says the Arlington-based center will first need to demonstrate a successful long distance arrangement.

"Eventually we would love to grow up here and expand our capabilities," DiMarino said, "but one step at a time."

As they settle in, DiMarino said the center will look to branch out to more funding agencies in Northern Virginia. They also plan to strengthen the connection to Virginia Tech's College of Architecture and Urban Studies, which also has a presence in the area.

Given the urban setting, it's a natural collaboration: as cities grow, an increased population demands more efficient energy and power solutions to sustain the grid.

Though traditionally energy-efficient buildings are heavily based on the architectural design and tweaks to the electrical infrastructure, DiMarino says CPES wants to work directly with the College of Architecture and Urban Studies to "design the architecture around the electronic

energy systems or tie in the electronic energy systems into the architecture."

"So we think if we work more closely with the architects, we could find ways to better incorporate power electronics into our everyday buildings," DiMarino said.

The center and the college have already demonstrated the possibilities of collaboration through their work on FutureHAUS Dubai, an innovative, interdisciplinary, and ambitious project to design and build a futuristic, modular smart home. While students and faculty from the College of Architecture and Urban Studies designed and built the structure and components of the home, CPES helped build the electrical "spine" of the home—which, thanks to the center's input, is a net-positive energy home that can sell energy back to the grid. This "spine" helped the lone American team earn a first-place victory in the 2018 Solar Decathlon Middle East in late November.

At the very least, DiMarino recognizes that the center's prominent new home in the nation's capital can raise awareness of the field of power electronics as a whole.

For DiMarino, it's a personal mission, considering her previous unfamiliarity with the field. Outside of her work with the center, DiMarino works extensively with an international power electronics group and has helped revive the student chapter at Virginia Tech.

She hopes to spread awareness of the field worldwide to attract further talent—and, she hopes, more women. While women make up a third of CPES faculty and students, DiMarino says there's still work to be done, particularly on a global scale.

But just as with the center's new presence in Northern Virginia, it's a process, one step at a time.

"I still feel like overall knowledge of power electronics is low. Maybe the first step should be to spread the knowledge of power electronics, and then we can work on encouraging women to go into that field," DiMarino said. "But you can't get more women into the field if people don't know what power electronics is." ■

URBAN LAB
DiMarino gives Dushan Boroyevich, University Distinguished Professor and director of CPES, a tour of the new lab space as it undergoes construction.

Photos: Erica Corder

Record number of early career faculty win national awards

The youngest faculty are poised to further research in critical areas, earning 11 National Science Foundation CAREER awards and five Young Investigator awards in 2018—a record high in college history. by STEPHANIE KAPLLANI

National Science Foundation CAREER Award, Office of Naval Research Young Investigator Award

Nina Stark

Charles E. Via, Jr. Department of Civil and Environmental Engineering

Nina Stark's education and training include geophysics, marine geotechnics, geosciences, and physical oceanography, and she has taken that work to places like Germany, Canada, and several U.S. states. Stark said having such a vast spectrum of training and experiences has allowed her to develop "a broad perspective, training in diverse methods, and a wide professional network" to find her niche.

Stark was awarded the National Science Foundation CAREER award to investigate the relationship between geotechnical soil properties and sediment transport with regards to sea-level rise and extreme events. By understanding the geotechnical elements affected by coastal processes, Stark and her research team hope to improve the understanding of erosion, sediment transport, and sediment stability, and develop novel methods for coastal soil characterization for naval applications, such as beach trafficability, which is part of the reason Stark was also a winner of the prestigious Office of Naval Research Young Investigator Award.

What is the impact of your research?
My research impacts the larger field of coastal sciences and engineering with regards to increasingly changing shorelines in response to extreme events, sea-level rise, and climate change. I am hoping to introduce and expand a geotechnical perspective on coastal sediment remobilization processes and coastal sediment characteristics through the development of novel methods, improved understanding of processes, and application in coastal engineering and for naval issues.

What do you like most about the field of geotechnical engineering?
Soil seems simple at first sight, but is actually highly complex. Particularly, adding coastal processes leads to more open questions than answers. Additionally, the work is connected to pressing societal needs and there is a great communication between practice and research, helping with transitioning research findings into the "real world."

MORE CAREER AWARD WINNERS

B. Aditya Prakash
Department of Computer Science

Changhee Jung
Department of Computer Science

Gang Wang
Department of Computer Science

Kyriakos G. Vamvoudakis
Kevin T. Crofton Dept. of Aerospace and Ocean Engineering

Nicole Abaid
Department of Biomedical Engineering and Mechanics

National Science Foundation CAREER Award

John Chappell
Department of Biomedical Engineering and Mechanics
Virginia Tech Carilion Research Institute

Very early in his academic career, John Chappell knew he wanted to help people, so he worked toward getting accepted into medical school. In order to come out on top of the competitive applicant pool, he studied electrical engineering while fulfilling medical school requirements through his minor in biomedical engineering. During one memorable class, Chappell recalls a professor showing a movie that demonstrated the basis of molecular motors, which drive cellular movement. "I sat in awe and knew that biomedical research had captured my imagination," Chappell said.

With the CAREER award, Chappell will research the role endothelial cells and pericytes have on the function and formation of blood vessels. Endothelial cells line the interior wall of blood vessels, whereas pericytes stabilize blood vessels by secreting a protein that coats themselves and endothelial cells. Chappell will study how pericytes and endothelial cells work together during vessel formation, and how they function during and after the vessel's formation. By understanding how pericytes and endothelial cells interact with one another, Chappell hopes to apply his findings to preventions and treatments for such conditions as diabetic retinopathy and tumor growth.

What is the impact of your research?
With every heartbeat, oxygen from the lungs is pushed throughout the entire body through blood vessels. Blood vessels are therefore essential for maintaining the health of every cell, tissue, and organ in the human body. My research is aimed at gaining more insight into how blood vessels form and function, with the ultimate goal of using that knowledge to improve medical treatments for human diseases where blood vessels are implicated. To gain that insight into blood vessel development and function, we are pushing the frontiers of experimental and computational modeling and integrating these approaches to harness recent technological advances in both domains. Specifically, we hope to leverage next-generation genetic sequencing approaches and super-resolution microscopy with multiscale computational models to learn more about how these critical conduits for blood flow emerge from and function with coordinated cellular behaviors and molecular interactions.

What do you like most about the field of biomedical engineering and mechanics?
Biomedical engineering positions someone at the crossroads of many different disciplines that converge to solve a medically-relevant problem. For instance, projects in my lab draw from materials science and mechanical engineering to explore how our cell types of interest react in certain environments. We apply that insight to develop new experimental models and "engineered tissues" that we are integrating with computational methods to better understand normal blood vessels and those in a pathological setting, such as diabetes.

CAREER AWARD WINNERS (cont'd)

Vassilis Kekatos
Bradley Department of Electrical and Computer Engineering

Yang Yi
Bradley Department of Electrical and Computer Engineering

Zhiting Tian
Department of Mechanical Engineering

Kevin Wang
Kevin T. Crofton Department of Aerospace and Ocean Engineering

U.S. Air Force Office of Scientific Research Young Investigator Award

Reza Mirzaeifar
Department of Mechanical Engineering

Reza Mirzaeifar began working with metals during his doctoral degree at the Georgia Institute of Technology. During his postdoc, he first began researching carbon-based materials. When he began his career as an assistant professor in mechanical engineering at Virginia Tech, he was inspired to combine metals and graphene to make a new composite material with exceptional mechanical properties. With the help of his U.S. Air Force Office of Scientific Research Young Investigator Award, he hopes to get closer to introducing a new class of materials to the world.

Mirzaeifar will use graphene to make metals stronger. To do this, he will incorporate layers of graphene material in metal to increase the composite's overall strength. Graphene particles act as blocks that prevent layers of atoms from dislocating and sliding, thus helping to prevent metal failure. The results of his research will have far-reaching impacts. Increasing the strength of materials will increase the efficiency of metals not only by making them stronger, but also more lightweight.

What is the impact of your research?
Discovering stronger materials is one of the long-standing problems in the history of engineering. Having stronger materials will impact the world from different angles. For example, imagine that we have a material with exceptionally high mechanical properties. Then we will be able to reduce the weight of many structures without changing the performance by using these new materials. Reducing even a slight weight in a plane, for example, can have significant effects on energy consumption. Having stronger materials can also reduce many of the fatal failures, such as structural collapses, that happen due to the materials' weaknesses.

What do you like most about the field of mechanical engineering?
Mechanical engineering, and particularly the mechanics of materials, is uniquely located at the interface between "pure" and "applied" sciences. While it is deeply rooted in pure sciences, such as mathematics, physics, and chemistry, it has a significant direct impact in many applications that affect many aspects of our daily life. ■

Read the full Q&A in the online edition of the Virginia Tech Engineer: eng.vt.edu/magazine

MORE YOUNG INVESTIGATOR AWARDS

Nina Stark
Charles E. Via, Jr. Department of Civil and Environmental Engineering

Wei Zhou
Bradley Department of Electrical and Computer Engineering

Zhiting Tian
Department of Mechanical Engineering

Xiaoyu "Rayne" Zheng
Department of Mechanical Engineering

Photos: Peter Means; John Chappell photo by Jim Stroup

Academy of Engineering Excellence

Engineers making an impact.

For the last 19 years, the College of Engineering has inducted new members into the prestigious Academy of Engineering Excellence. The academy was founded in 1999 by F. William Stephenson, former dean of the college, and by the college's advisory board.

"The alumni who are inducted into the academy are standouts in their respective careers, embodying the character and caliber of engineers we aspire to produce at Virginia Tech," said Julia M. Ross, the Paul and Dorothea Torgersen Dean of Engineering.

The 2018 academy inductees were nominated and selected from 74,000 living alumni for having achieved exceptional career successes and represent a wide range of disciplines and backgrounds, reflecting the broadening of the field of engineering. ■

The 2018 Academy of Engineering Excellence inductees, from left: Dan Sable, Dushan Boroyevich, Kevin Crofton, Dean Julia Ross, Lucy Nowell, Kirk Schultz, and Jeff Babione.

"The alumni who are inducted into the academy are standouts in their respective careers, embodying the character and caliber of engineers we aspire to produce at Virginia Tech."

—Julia M. Ross, the Paul and Dorothea Torgersen Dean of Engineering

JEFF BABIONE, '85
Bachelor's, aerospace and ocean engineering
Executive vice president and general manager of advanced development programs for Skunk Works at Lockheed Martin Aeronautics Company

DUSHAN BOROYEVICH, '86
Doctorate, electrical engineering
National Academy of Engineering member, University Distinguished Professor, and Director of Center for Power Electronics at Virginia Tech

KEVIN T. CROFTON, '82
Bachelor's, aerospace engineering
President and COO of SPTS Technologies and executive vice president of Orbotech Inc.

LUCY NOWELL, '93, '98
Master's and doctorate, computer science
GS 15-10 computer scientist, program manager, and computer science team leader of the Computational Science Research Division at U.S. Department of Energy Office of Advanced Scientific Computing Research

DAN SABLE, '85, '91
Master's and doctorate, electrical engineering
Founder and CEO of Virginia Power Technologies Inc.

KIRK H. SCHULZ, '86, '91
Bachelor's and doctorate., chemical engineering
President and professor of chemical engineering at Washington State University

Outstanding students of 2018

Our undergraduate and graduate students break boundaries in space science, ovarian cancer research, and public policy.

For his senior capstone project, Michael Sherburne led a team of students to develop a new nuclear fusion tool to generate neutron radiation for experiments. Sherburne, the college's Outstanding Senior of the Year, graduated with honors in electrical engineering from the Bradley Department of Electrical and Computer Engineering.

"I am excited to find new ways to improve our scientific endeavors and to inspire others to push beyond boundaries," Sherburne said. As an undergraduate, researcher, and leader, Sherburne was able to explore interests from space science to public policy. He was also a squadron commander in the Air Force ROTC and platoon leader for the Virginia Tech Corps of Cadets, collectively responsible for the training of 70 cadets.

On the political front, Sherburne co-founded Students on Capitol Hill to influence legislative bills affecting the space industry, subsequently earning him an internship in Congressman Robert Hurt's office.

A William C. McAllister Leadership Scholar and 21st Century Studies Fellow, Sherburne led an investigation into water quality issues within Sri Lanka and was the lead electrical engineering undergraduate researcher for Space@VT's Plasma Diagnostic Laboratory.

Currently, Sherburne is serving as a developmental engineering officer in the U.S. Air Force, where he is pursuing his graduate studies. ■

NAME Michael Sherburne **AWARD** 2018 Outstanding Senior of the Year

Alexandra Hyler said her Virginia Tech experience harks back to one of her beliefs about education: "You are here for a bigger purpose than a piece of paper."

Hyler, the Graduate Student of the Year for the university who graduated in May with a doctorate in biomedical engineering, had been interested in biological sciences and considered a career in medicine.

Her work focuses on women's health, with an emphasis on ovarian cancer. This year, Hyler led a published study that examined the effects of fluid shear stress on ovarian cancer development and progression, which found that even normal fluid flow in the abdominal cavity can cause cancerous and benign cells to become more aggressive.

Hyler served as president of the Graduate Student Assembly, president of the Virginia Tech chapter of the Biomedical Engineering Society, and was co-chair of the graduate student committee for the university's Women's Alliance, among other activities. She also found time to mentor engineering students.

Since graduation, Hyler is continuing her research at CytoRecovery Inc., a company currently headquartered in the Virginia Tech Corporate Research Center, located in Blacksburg, Virginia. ■

NAME Alexandra Hyler **AWARD** 2018 Outstanding Graduate Student of the Year

Photos: Jack Beach

Photos: Christina Farnusich (top); Peter Means (bottom)

THE FUTURE OF FARMING

Spurred by a graying workforce, Virginia Tech researchers are laying the groundwork for an accessible future of agriculture. **by ERICA CORDER**

ASSISTED MOBILITY: Ron Burleson, a flower and beef farmer suffered a stroke that severely limited his ability to work. Though he can walk, his all-terrain wheelchair helps him navigate his field and greenhouse.

Photos: Erica Corder (except last spread)

THE WEEK THAT WOULD CHANGE TERRIE WEBB'S LIFE IS ONE SHE DOESN'T REMEMBER. In that week, the then-57-year-old orthodontist clinic admin from Prince George County, Virginia, was rushed from a doctor's appointment about her swollen, purple hand straight into emergency surgery. Where her memory picks back up, she recalls being informed she'd suffered a blood clot that traveled to her shoulder. Despite emergency surgery, she'd lost the full functionality of her right hand—and subsequently, her job.

Half of Terrie Webb's right hand no longer has feeling and cannot grasp objects.

TERRIE WEBB
Flower farmer

Above: Terrie Webb stands in front of her greenhouse.

Below: Terrie Webb using her modified tools.

After a year spent recovering, a friend encouraged Webb to turn her flower gardening hobby into a full-time job as a farmer. Webb was entering deeper into an occupation inextricably linked to physical capability. How would she tend to her snapdragons and lisianthus flowers without the full functionality of one of her hands?

The answer for Webb—and possibly for farmers across the U.S.—was found in an engineering lab.

A graying, staying workforce

Throughout the U.S., an aging demographic of small to midsize farm owners and workers is responsible for a large portion of the nation's agricultural backbone.

Large scale farms—classified as having an income of $1 million or more—output the majority of food production in the U.S. But United States Department of Agriculture data reveals that small and midsize family farms make up 96 percent of farms in the U.S. They supplement production, largely of poultry and hay, and provide broader access to food. Without them, there are no farmers markets or grocery store shelves stocked with locally-sourced produce.

"The interesting nuance is if everybody was a large farmer, it just becomes a commodity," said Robert Grisso, professor and interim department head of Virginia Tech's Department of Biological Systems Engineering. "All of a sudden, you lose the local flavor."

On top of an already tough economic climate, farmers themselves are largely aging, the average age being 58.3 years old and rising.

It's an unsustainable recipe: a graying

RON BURLESON
Flower and cattle farmer

A LIFT UP
Ron Burleson stands next to the tractor he and his wife, Susie, purchased after Ron suffered a debilitating stroke. An engineer custom designed a lift into the tractor that allows the 6'5" farmer to safely get in and out of his tractor with the flip of a light switch mounted to the tractor's frame.

workforce, economic instability, and a labor-intensive profession.

But farmers adapt, partly out of necessity. More importantly, they do it because farming is a labor of love, explained 59-year-old Ron Burleson, a flower and beef farmer from Unionville, Virginia.

"You gotta like what you do. You ain't gonna get rich," Burleson said. "You gotta really enjoy it and not mind working hard."

Burleson and his wife, Susie, would know. Both Virginia Tech College of Agriculture and Life Sciences alumni, they've had to work even harder lately, he said. Five years ago, Burleson suffered a stroke that severely limited his mobility.

He's found ways around it, with the help of technology like his Trackchair, an all-terrain wheelchair that helps him navigate his field and greenhouse. A national USDA program called AgrAbility also connected Burleson directly to an engineer who custom designed a lift that allows the 6'5" farmer to safely get in and out of his tractor.

AgrAbility connects farmers in need of assistance with appropriate resources, like physical therapists and university researchers. In Virginia, a National Science Foundation grant is funding Partnerships for Innovation, a collaborative effort between the AgrAbility Virginia Program, local company TORC Robotics, and Virginia Tech faculty from agriculture and life sciences and engineering.

The partnership has one main goal: To design assistive technology for a dozen volunteer farmers with disabilities throughout the state—and to do it across disciplinary lines.

ON TOP OF an already tough economic climate, farmers themselves are largely aging, the average age being 58.3 years old and rising. It's an unsustainable recipe: a graying workforce, economic instability, and a labor-intensive profession.

Combining fields, improving yields

Transdisciplinary convergence ultimately results in better products for farmers.

"You can have the technology, but it doesn't necessarily mean that's what's going to be the best solution," said AgrAbility Virginia program coordinator Kirk Ballin. "Somebody doesn't necessarily want the latest and the greatest technology. What they want is something that's going to make their life better." Food systems expert Kim Niewolny, AgrAbility Virginia director and a co-principal investigator of the NSF grant, agreed.

"The technology is a possibility. However, it has to integrate into the person's life," Niewolny said. "To begin, you need to listen to the farmers before you can understand and respond to their needs. Their local context and experience is what counts."

Researchers from the College of Engineering are finding this to be true as they work on assistive devices for farmers through the grant. When designing a wearable exoskeleton, for example, agriculture faculty and farmers discouraged the engineers from making complex devices with intricate parts. If the exoskeleton required specialized knowledge to maintain, characteristically independent farmers likely wouldn't bring it to someone else to fix. They just wouldn't use it.

The researchers took it to heart and approached the design process differently—something that might not have happened if the engineers spent their time siloed in their labs.

Throughout the next few years under the grant, researchers from the College of Engineering will continue to learn from their agriculture colleagues and volunteer farmers in this style of proactive design.

The hope is to avoid designing high-tech products that farmers don't actually need or want. It's not always about revolutionizing the agriculture industry through new gadgets or equipment—a lesson many startup companies could learn from, explained Blaze Currie, a leader within the National FFA Organization, formerly known as Future Farmers of America.

"It's interesting because a lot of them are out of Silicon Valley, and so they have a lot of knowledge about how to make this stuff work. They sometimes, I think, have a distant gap between what's actually valuable to a farmer," Currie said. "They get to working with farmers then find out that, yeah, farmers might think it's cool, but it's not something that they're willing to pay for because it doesn't actually increase their yields or increase their profit."

Over the remaining two years of funding, engineering faculty will continually improve iterations of custom devices that address each farmer's unique disabilities and needs.

This includes the lightweight exosuit, which aims to lighten the pressure on farmers' backs and knees, led by mechanical engineering assistant professor Alan Asbeck. Mechanical engineering professor Alex Leonessa is simultaneously designing a

"SOME PEOPLE ARGUE

'Well, what are you trying to do, to get farmers to work until they're 90?' And that's really not the intention. The intention is to make sure that they—using this technology from an earlier age—can age gracefully so that when they are 65, they don't have all of these problems."

robotic glove that could assist farmers like Webb who have trouble gripping objects or who have arthritis.

These devices, explains Leonessa, are intended to keep today's farmers doing what they love, but not at the expense of their bodies. Ultimately, the findings from the collaborative effort also provide preventative measures for future farmers.

"Some people argue, 'Well, what are you trying to do, to get farmers to work until they're 90?'" Leonessa said. "And that's really not the intention. The intention is to make sure that they—using this technology from an earlier age—can age gracefully so that when they are 65, they don't have all of these problems."

Industrial and systems engineering assistant professor and human factors expert Divya Srinivasan is leading research efforts to ensure the devices the group builds will be beneficial, and not harmful, to the wearers.

"There's a trend for technology to get designed by technologists," Srinivasan said. "We're trying to reverse that trend by saying we need the human piece right at the design stage."

Srinivasan is also leading an international research coordination network, based out of Virginia Tech and funded by the National Science Foundation, called Helping Agriculture Remain Vital Through Engineering, Science, and Technology.

Through the network, experts in engineering and agriculture and farmers across the globe are evaluating risks and benefits of emerging technologies, particularly for small and midsize farms.

The network might not have to turn too far to find these new technologies: Many of them are being developed right at Virginia Tech.

Inventing tomorrow's farms

In labs across Virginia Tech, researchers are building on a rich history of agriculture and engineering dating back to 1920, when the university became the first east of the Mississippi to provide an agricultural engineering curriculum.

Leonessa divides the work engineers do in agriculture today into at least two categories: precision technology and assistive technology.

Precision technology, he explains, is about robotic systems that autonomously tackle monotonous or physically demanding tasks at the push of a button.

It's the concept behind robots built by agBOT, a student team Leonessa advises that recently won first place in a national agricultural competition. The agBOT team designed an autonomous harvester that rolls through a watermelon patch identifying melons, slapping them to tell if they're ripe, then harvesting them.

Electrical and computer engineering assistant professor and collaborative autonomous vehicle expert Pratap Tokekar, meanwhile, is building a combination drone and ground vehicle system that can monitor and help control the height of vegetation—crucial for plant and soil health.

The drone scours the field, collecting data on plant height using on-board cameras, before landing to recharge its battery on the ground vehicle.

DIVYA SRINIVASAN
Technology evaluation

Professor Divya Srinivasan is a human factors expert tasked with evaluating technologies being created at Virginia Tech and beyond.

In Srinivasan's lab, student researchers test exoskeletons in the hopes of ensuring the technology is beneficial, and not harmful, to wearers.

Ph.D. student Satyajit Upasani serves as a test subject by wearing an exosuit and completing tasks as other researchers record performance data.

TOMONARI FURUKAWA
Autonomous grape harvester

Mechanical engineering professor Tomonari Furukawa is leading research to build an autonomous grape-harvester that can delicately pick table grapes. Above: Furukawa's students show off the harvester.

Furukawa's robot can spot when grapes are ripe, and human pickers can direct the robot to harvest.

Assistive technology, on the other hand, is about enabling the farmer to do the work themselves. It's exactly the type of work Leonessa and Asbeck are doing in their labs, through the Partnerships for Innovation grant.

"We are not designing robotic systems to do the job of the farmers," Leonessa explained. "What we are trying to do is make the job easier for the farmers."

Then there's the tech that meets in the middle: both autonomous and assistive. Not taking the human out of the loop, but augmenting human capabilities.

Mechanical engineering professor Tomonari Furukawa is building an autonomous grape-harvester that can delicately pick table grapes—a task difficult in research sponsor Mahindra's home location of India. These grapes are so delicate, explains Furukawa, they must be individually wrapped in paper to prevent overexposure to the sun.

The grapes' ripeness is difficult to discern for the human eye, but using cameras and computer vision algorithms, Furukawa's robot can spot when grapes are ripe and human pickers can direct the robot to harvest.

Fellow mechanical engineering professor Kevin Kochersberger uses drones to identify areas in fields that need extra care due to drought or weeds. Then, a drone pilot can map a route to precisely spray fields with weed remover or pesticides as needed.

To get to the real world though, these forward-looking robots and devices built by university researchers must eventually be produced at scale. Only then will this technology be affordable, particularly for small and midsize farms.

"The longer people can work on it and create more efficient ways to build it, then the cheaper those products get, which makes them more accessible to farmers," Currie said.

How Webb found her joy

Ideally, the work being done at Virginia Tech will not stay at the university. It's why the Partnerships for Innovation sought a company partner, to help take their innovations beyond the scope of the university and allow them to reach the fields as quickly as possible.

It's how Webb still farms her flowers today. After her blood clot, Webb was connected to AgrAbility Virginia and engineers at Virginia State University.

They helped her build unheated greenhouses and modified the tools that she could no longer use. The fix was simple: they extended the handles on her tools so they fit snugly in between her thumb and palm, effectively locking the tools in place.

Fourteen years later, you'll still find Webb in her flower fields using her modified tools. The only difference you might notice is her switch from annuals to perennials—she says they are a bit easier to maintain.

She doesn't plan to stop growing them anytime soon.

"You don't get rich on it, but it's just a joy," Webb said. "You go out in the morning and you pull weeds and everything, and it's just —it's good for the soul." ■

Photos: Peter Means (this spread)

Robert Thamm, a resident of Cicero, Chicago, was unaware of the potential exposure to lead in his drinking water.

Tapping the ripple effect

Virginia Tech engineers lead an EPA-funded effort that taps a growing crowd of consumers who want to learn how to better protect themselves from lead. **by LINDSEY HAUGH**

IGNORANCE IS NOT BLISS

for the residents of Cicero, a suburb just outside of Chicago, Illinois. No, says Rev. Diane Johnson: Ignorance is catastrophe. Especially when the water you drink every day could kill you.

The community Johnson has served as a minister of the Gethsemane Lutheran Church in Cicero since 1981 are her people—her world—along with her canine companion, Rex.

Johnson's parsonage was built sometime after 1920, complete with lead pipes. Back then, much of Cicero was an airfield before it became a neighborhood.

"I didn't know that I had lead pipes until last year," said Johnson.

In Chicago's suburbs, including Cicero, Berwyn, and Robbins, lead service pipes are prevalent—totaling hundreds of thousands of networks of pipes. Most U.S. homeowners own the infrastructure from the property line to their home and the city or town owns the pipes from the property line to the water main.

Unfortunately, like many of her neighbors, Johnson's pipes are galvanized iron at the property line and then transition to lead as they reach the foundation of her home. She would need to spend as much as $10,000 to replace all of the antiquated piping that leaches lead into her tap water.

One temporary remediation strategy to clear the lead from Johnson's drinking water is to continuously flush, every day, allowing the water to run for more than 20 to 30 minutes, or the time it takes to run one load of laundry.

Cicero resident Diane Johnson works with Virginia Tech researchers to inspect lead pipes in her basement and at her property line. Johnson's kitchen faucet can't be fitted with a water filter, so she uses a filtered pitcher.

"So now we drink filtered water out of this pitcher," said Johnson as she filled a conventional water pitcher which has a built-in filter.

In August 2018, Sid Roy spoke at a press conference that brought public awareness to the lead-in-water contamination in the towns of Cicero and Berwyn.

"If you are taking a daily bath or using your garden hose every week, then we compare your results to those who aren't using their water at all," said Siddhartha "Sid" Roy, Virginia Tech post-doctoral researcher.

Initial profiling sampling—where 20 or more one-liter samples are taken consecutively from the tap—in some Cicero and Berwyn homes showed that after 10 minutes of flushing, lead was still prevalent, reflecting a persistent lead-in-water problem that was not revealed in the state-sanctioned testing. The highest lead level detected was at the kitchen tap in Johnson's church—28 times the U.S. Food and Drug Administration's maximum allowable level of lead in bottled water.

More than 100 three-bottle water-testing kits—the same kind used in Flint, Michigan—were distributed in Cicero and Berwyn. Results showed that 1 in 3 households tested in both towns had concerning lead concentrations.

The federal law, called the Lead and Copper Rule, requires that if 90 percent of homes tested in a city are below 15 parts per billion, the city is in compliance. While the first draw 90th percentile lead levels in Cicero and Berwyn were below 15 ppb and met the much-criticized law, lead in the flushed samples, referred to as second and third draws, did not drop, but stayed above the FDA standard and sometimes even increased.

Flushing alone would not adequately reduce lead exposure risk from Cicero and Berwyn water.

"So now we drink filtered water out of this pitcher," said Johnson as she filled a conventional water pitcher which has a built-in filter. Her kitchen sink faucet does not have the part needed to attach a $30 water filter that residents are encouraged to buy to minimize the impacts of lead.

Johnson, who co-founded Ixchel, sounded the alarm after dirty particles in her kitchen water made her skeptical of public officials saying their water was safe.

A hotbed of lead pipes

Ixchel, a community activist group founded by Cicero and Berwyn residents two years ago to bring social awareness to such hazards, first began testing the community's water with Virginia Tech in 2017.
Rev. Johnson, who co-founded Ixchel with Delia Barajas, sounded the alarm after dirty particles in her kitchen water made her skeptical of public officials saying their water was safe.

Johnson and Barajas meticulously compared Virginia Tech's water-testing instructions with those that the city had provided, uncovering that the city's instructions were erroneous and that following them could yield lead levels much lower than the real levels. Johnson had read about the Virginia Tech researchers that had come to Flint's aid, and so she sought them out.

Roy, along with other Virginia Tech researchers, responded immediately, knowing that the outlying Chicago suburbs, as well as the Windy City, "are [a] hotbed of lead pipes in the U.S.," said Roy.

Roy has worked alongside the Virginia Tech water study team since 2015 when

Citizen activists of the group Ixchel in Cicero.

the Flint water crisis broke, so he refers to Flint when explaining how bad science and unethical decisions by scientists and engineers can result in societal harm. By working in places like Chicago, Roy seeks to prevent and reverse that damage, which validates his passion to bring together a community of advocates, hence broadening the ripple effect.

Together empowered

Experts now say that 844 million people live without access to safe water. How will engineers, scientists, policymakers, and citizen advocates work together to mitigate this growing national epidemic?

In spring 2018, the U.S. Environmental Protection Agency awarded $1.9 million to Virginia Tech, North Carolina State University, the University of Iowa, Louisiana State University, and Texas A&M to uncover, detect, and control lead in drinking water.

"There are three specific case studies that this grant focuses on," said Kelsey Pieper, Virginia Tech research scientist. "Michigan residents because the state is implementing a more ambitious rule with consumer-centric elements, private well owners who are 100 percent responsible for detecting and controlling water lead risks, and residents protected by the existing Lead and Copper Rule, but live under circumstances that historically make compliance difficult to achieve." Chicago suburbs fall under the latter of the three case studies.

"You have a lot of vultures that come out here and try to sell residents $2,000 filtration systems that they don't need," said Battle as she shakes her head.

By working directly with consumers and citizen scientists over the next three years, the EPA-funded project is designed to increase public awareness of lead in water and plumbing on a national scale.

"We are tapping a growing 'crowd' of consumers who want to learn how to better protect themselves from lead, and in the process, create new knowledge to protect others," said Marc Edwards, University Distinguished Professor, explaining how citizen scientists come to fruition.

Together, Edwards, Roy, and Pieper, plus a collaborative team of university engineers and scientists, have been uniting one of the largest citizen science engineering projects in U.S. history. The end goal: To help individuals, like Johnson, and communities, like Cicero and Berwyn, deal with the shared responsibility for controlling exposure to lead in drinking water through a combination of low-cost sampling, outreach, direct collaboration, and modeling.

Long before the Cicero sampling project or the Flint water crisis, there was the Washington, D.C., water crisis that began in 2000 and spanned four years, ending with the Centers for Disease Control and Prevention admitting it had misled the public about the risk of lead in the District's drinking water.

But because of Flint, not D.C., Edwards said citizen scientists seem to have become more empowered and the public and media have paid more attention to water issues. The door has opened for consumers and activist groups, like Ixchel, who want to learn how to better protect themselves.

Whether from wells or municipalities, we all consume water and can collectively work together to reduce health risks, said Edwards.

The choice of life

Making sure basic needs like air, food, shelter, and water are taken care of is not something Chivonne Battle takes for granted.

For Battle, unveiling the truth in Cicero and Berwyn is personal. Growing up as a person of color in an impoverished environment, "life, liberty, and the pursuit of happiness were not spoken to, or for, me," she said. The desire to protect the most vulnerable stems from her personal experience with poverty.

"I was only exposed to happiness as defined by the government: canned peanut butter, cheese blocks, and powdered milk—all of which was shared with unwelcomed multi-legged friends," said Battle. "In poverty, you do not get to choose life, it is chosen for you."

Through sheer determination, Battle built a better life for herself through the power of education. Now, a two-time Hokie with degrees in materials science engineering and working toward her doctorate in planning, governance, and globalization in the School of Public and International Affairs, Battle fully comprehends what advocacy and persistence truly mean.

Chivonne Battle, two-time Hokie, shows a Chicago Tribune story about lead in water found in Cicero's water supply.

Battle sits with Cicero resident Robert Thamm to go over elements of a water testing kit.

"Because there were communities that may not have known … I have literally been able to go under bridges, you know, that most people don't cross, and simply pull up next to someone's house and say, 'Hey, do you know what the lead levels are in your drinking water?" Battle said about how she's reached different groups of people.

This past summer, as part of the EPA-grant with Roy, Pieper, and Edwards, Battle worked one-on-one with Chicago residents to rectify social injustices. Her doctoral study is to "research and develop a way to reverse the physiological and psychological impact of socio-economic despair." In essence, Battle hopes her work can reverse poverty while pursuing the truth.

Battle sees the current water problems in the three Chicago neighborhoods as her chance to help the voiceless. It's also how she came to meet Robert Thamm, resident of Cicero and a retired chef whose upbringing was similar to Battle's living under impoverished conditions.

Thamm was unaware of the potential exposure to lead in his drinking water. But, Battle was able to reach him by simply responding to his request for a testing kit to be delivered to his front door. Thamm graciously invited her into his home so that she could examine his kitchen faucet to see what kind of filter he needed.

"Robert made my day. Because they (residents) remind you why you do this," Battle said.

One by one, Battle takes her time with residents, visiting them in their bungalow row homes, collecting test kits, and asking about filters.

"You have a lot of vultures that come out here and try to sell residents $2,000 filtration systems that they don't need," Battle said, shaking her head. "A lot of times, you have communities, small communities like this, they unfortunately are overlooked or taken advantage of."

Battle explained that without the right information and education, choices are made for residents that are poisoning their mind and body.

"Reversing this notion is important to me," said Battle. "Impoverished communities are not always afforded the tools or truths to choose. All human beings should have the choice of life. And I just want to do my part to keep that going." ■

Photos: Peter Means

Out of the lab, into the field

THE **FOG HARP'S** POTENTIAL TO DELIVER MORE CLEAN WATER ACROSS THE GLOBE IS THREEFOLD, BUT TAKING THE PRODUCT TO MARKET REQUIRES SAVVY INDUSTRY PARTNERS. **by EMILY ROEDIGER**

Jonathan Boreyko (left) and Brook Kennedy set-up a full-scale prototype at Blacksburg's Heritage Community Park.

In the three months following the Virginia Tech fog harp's public debut on March 28, 2018, Jonathan Boreyko and collaborator Brook Kennedy received almost 100 outside inquiries about the project. That's roughly one email or phone call per day.

Boreyko, an assistant professor in the Department of Biomedical Engineering and Mechanics, was floored by the fog harp's many fans. He and Kennedy, an associate professor in the Department of Industrial Design, heard everything from the practical to the fantastical.

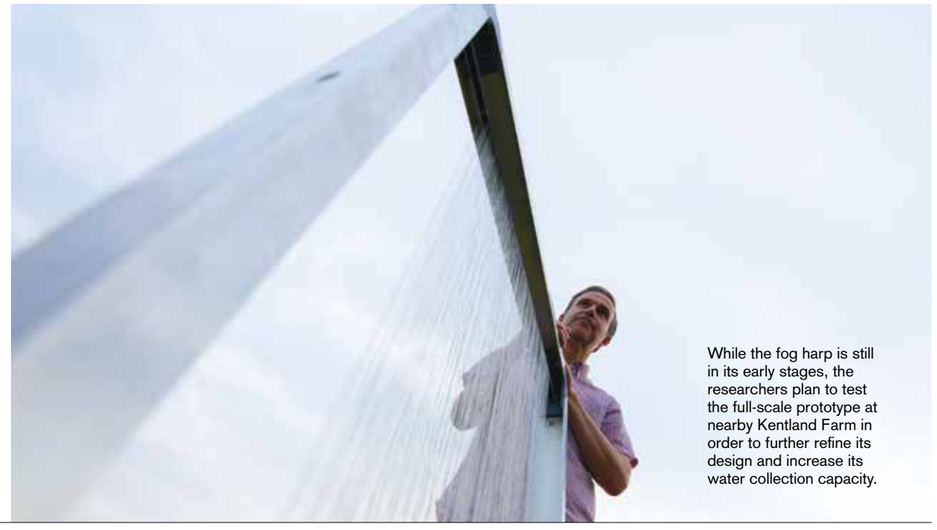
A vineyard in Mexico wanted to know how to utilize the fog harp's technology to quench the thirst of its grapes, while a nonprofit in Malaysia was interested in supplementing the flow of clean drinking water to local communities. An ambitious Russian scientist thought fog harps could be suspended from blimps in the air to power water turbines on the ground below.

The fog harp, it seemed, had struck an international chord. "I've just been amazed by the amount of interest we've had," said Kennedy.

The invention is a novel combination of science and design, one that could potentially revolutionize the world's approach to fog harvesting. A passive, durable, and effective method of water collection, fog harvesting uses nets to catch the microscopic droplets of water suspended in the wind that constitute fog.

As wind moves these water droplets through the nets, some get caught on the net's suspended wires. These droplets gather and merge until they have enough weight to travel down the nets and settle into collection troughs below.

While traditional fog harvesters use mesh netting to catch these droplets, the fog harp opts for a vertical array of wires instead, a design change that increases their collection capacity for clean water by threefold. That key discovery is what prompted the onslaught of attention from researchers, entrepreneurs, farmers, philanthropists, and citizen-scientists around the globe—not to mention investors.



While the fog harp is still in its early stages, the researchers plan to test the full-scale prototype at nearby Kentland Farm in order to further refine its design and increase its water collection capacity.

Missed connections

That last category of interest began to intrigue the researchers. From the project's inception, both had hoped to find a smoother, faster path through the fog harp's stages of development and distribution. Often that meant finding an industry partner who might be interested in helping them build and refine an inexpensive, large-scale prototype to field test, or fund future iterations of the technology. Perhaps both.

But after several phone calls with potential investors, Boreyko and Kennedy started to accrue more questions about that process than they could answer on their own. Science was one thing, but screening investors? Asking tough questions about timelines and milestones? Filing patent applications and drafting licensing agreements?

"We thought a few of these processes just seemed really confusing and overly complicated," said Boreyko. "Some of these emails we'd get from investors were impenetrable. As an academic, I was trained to conduct research and write papers for publication that summarize that research. But no one taught me how to file for a patent."

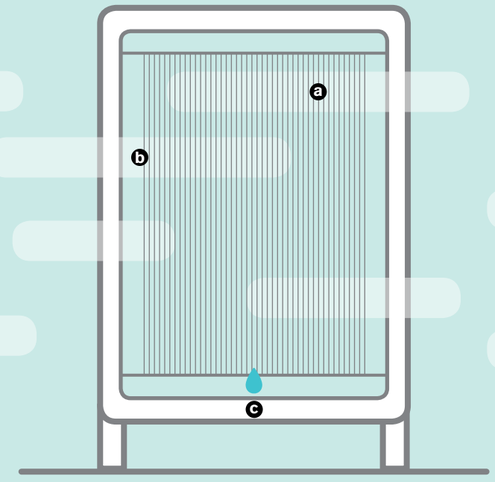
Kennedy, who has worked professionally in industrial design and product development, also found these negotiations to be a bit daunting without a company behind him representing the team's best interests.

"You're trying to be smart and strategic with people who seem like they really want to help you, but you just don't know," said Kennedy. "How do you partner with external businesses from inside academia? And how do you deal smartly as a business person?"

Connecting with commercialization resources

Boreyko and Kennedy were encountering the complexities of technology commercialization first-hand. They had come up with a novel idea, designed a model, and tested it in the lab to verify results. But even though their invention had the potential to alleviate a

HOW A FOG HARP WORKS



a Consisting of an array of closely-spaced vertical stainless steel wires, it works like a fog net without the horizontal wires.

b The gaps in the array are small enough that lots of droplets are captured as fog passes through, but because there aren't any horizontal wires getting in the way, water flows down the vertical wires much more readily.

c Water flows down into a collection trough. This method allows for three times more collection of water than the traditional fog net.

very real and pressing problem (experts now predict that two-thirds of the world's population won't have access to enough clean water by the year 2025), they weren't quite sure how to take the fog harp into the communities that needed it most.

"Moving technologies from the lab to market is critical," said Boreyko. "But it's not a core part of my job."

And without the appropriate resources to navigate that process, the fog harp's journey might have ended here – in the lab, on a shelf, or stuck somewhere inside a tangle of corporate legalese.

"But thankfully, Virginia Tech is really going in the right direction in terms of addressing that challenge," said Boreyko. "The university recognizes that this is the hardest gap for faculty to cross. I'm glad we're seeing more resources and services available in that area."

One of those resources includes LINK, the university's Center for Advancing Industry Partnerships,

Even though their invention had the potential to alleviate a very real and pressing problem, they weren't quite sure how to take the fog harp into the communities that needed it most.

in collaboration with Virginia Tech Intellectual Properties. It was through these organizations that Boreyko and Kennedy first connected with Grant Brewer, associate director of technology commercialization, who not only helped the researchers vet potential investors, but also guided them through the provisional patent application process – the first step toward commercialization.

Why choose the route of commercialization? "Because as a university, we don't make and sell products," said Brewer.

If technology invented at Virginia Tech has the potential to change the world, commercialization is the fastest, most efficient way to make it happen. That's where patents and industry partners come in, Brewer explained.

Often industry partners already have the facilities, resource infrastructure, and distribution networks in place to develop and mass produce a final product or field test a working prototype in a location prime for deployment. They offer pathways and expertise that universities can't.

"But development is very expensive," said Brewer. "So patents are a way for industry partners to protect their investment. In general, they protect opportunities for commercial endeavors." Patents give companies a chance to recover the capital that gets spent on research and development, since products in the lab usually have a long way to go before they're ready for the field.

"At the end of the day, patents provide important foundations—foundations that others can build on to serve the greater good. With commercialization partners, groundbreaking technologies like the fog harp have the potential to deliver significant global impact," Brewer said.

Appreciating an objective evaluation

Just like a potential industry partner would, Brewer first evaluates new technology for its market potential and novelty, or patentability, to gauge commercial viability. In the case of the fog harp, the invention's promise was clear from the start.

"I found that it was a pretty straight-forward and efficient approach to a problem in an existing field with a lot of possibility," said Brewer. "I saw the novelty of the design and its performance improvements over existing solutions, and with it, the product potential."

All of those emails sitting in Boreyko's inbox didn't hurt, either. The fact that the fog harp had garnered so much public attention in a short amount of time indicated that a market for the invention did indeed exist.

"Having someone who's more business-minded on the team has been incredibly helpful," said Kennedy. "Grant could ask those hard questions and push back on details. It's nice to have that buffer between academia and the outside world."

Boreyko also appreciated Brewer's involvement as a buffer between short-term needs and long-term interests.

"What faculty need more than anything, at least in the short-term, is more funding for the research," said Boreyko. "Sometimes that need for funding in today's competitive academic climate can overshadow long-term strategies for licensing and partnerships. So having an unbiased third party here at Virginia Tech to help us bypass that potential conflict of interest has been really valuable."

Boreyko (left) studies fluid mechanics at Virginia Tech, while Kennedy is an industrial designer at the university with a professional design background.

Finding the right partner

Thanks to collaborative efforts, the fog harp creators are currently in talks with a clean technology company that facilitates the more efficient use of natural resources. Although the agreement hasn't been finalized yet, both sides are optimistic about the fog harp's potential to contribute to resolving water scarcity challenges across a multitude of scales—from individual households to commercial as well as industrial applications.

Finding a good fit for the fog harp was important, Boreyko and Kennedy said, and they feel they've connected with the right partner.

Over the next several years, the company will help the team optimize the manufacturability, durability, and overall performance of the fog harp. The first full-scale tests are set to take place at Virginia Tech's Kentland Farm and in the future the researchers hope to conduct field tests in a decentralized international location.

The pending partnership not only moves the fog harp closer to communities around the world, but Boreyko and Kennedy say it's also important for another reason: It has confirmed their approach to research with a cross-disciplinary, real-world focus.

"I don't think it's a coincidence that the fog harp is a collaboration across disciplines and that it has attracted an industry partner so quickly," said Boreyko. "From the beginning, this project wasn't just about 'Look what we can do.' We were interested in making a discovery that was actually amenable to real-life implementation. The more we can cross-collaborate, the more we can close those gaps in translation more effectively."

Kennedy agreed. "I know a lot of people talk about collaboration, but that concept wasn't just lip service for us. This was pure and wonderful science that had its eye on real-world application." ■

Photos: Peter Means

WHAT'S NEXT FOR HOLDEN HALL?

WITH A GREEN BUILDING CERTIFICATION OF LEED SILVER, THE ENHANCEMENT AND REPLACEMENT PROJECT WILL ALLOW TWO DEPARTMENTS TO RECRUIT THE BEST FACULTY AND STUDENTS AND FURTHER BUILD UPON THEIR SHARED HISTORY. **by LINDSEY HAUGH and RICH POLIKOFF**

Photo: Peter Means

RECRUITING THE BEST AND BRIGHTEST

Holden Hall, built in 1940, was originally known as the Mineral Industries Building and named for Roy Jay Holden, who was a professor and geology department head in 1949. He cited Virginia's first gas well, located water wells when a shortage threatened Virginia Tech, and assessed the safety of the Claytor Lake Dam site.

Holden's legacy extends to the classroom where he stimulated a lifelong scientific interest in his students. Today, the building is home to the departments of mining and minerals engineering and materials science engineering.

Success of the college is fundamentally tied to facilities and capabilities. At the current age and state of the building, both departments are not positioned for sustained success. Just as modern, state-of-the-art facilities are essential in attracting the best athletic talent, so are the top academic facilities essential in recruiting talented faculty members and students.

Starting this summer, a refresh of the facility will provide the opportunity to design laboratories that are optimized for future growth, cutting-edge research, and teaching that crosses the boundaries of established disciplines. The new research and instructional laboratories will more than double the current sizes. This project will renovate the building's existing three story south wing. New construction will also include the demolition of the single story east and north wings, the replacement of the north wing with a new four story, and the replacement of the east wing with a new three story wing. Each replacement wing will overlay the footprint of the existing single story wings. The replacement wings will total approximately 86,600 gross square feet. The overall building will total 102,000 gross square feet of new and enhanced space upon completion of the project.

The added space will enable growth for both departments that will position them to be among the largest and most productive undergraduate and graduate programs in the nation.

TRANSFORMATIVE SPACES

One of most technologically unique features in the new wing will be the 1,281square foot Center for Autonomous Mining and Robotics. In the center, students will engage in autonomous mining and work with material that is three to four feet deep. This material will come from a high-purity limestone quarry—pure calcium carbonate that eliminates health concerns such as silicosis. The top level of the two-story mine will be a glassed-in area where students can learn advanced automation methods.

Mining engineering students will be the primary beneficiaries of the mock mine, but it will enhance the education of other students, including mechanical engineering, electrical engineering, and those pursuing computer modeling and data analytics. Once the materials are taken out of the ground and refined, materials science and engineering students and faculty will use high-tech equipment, including transmission electron microscopes, to analyze and study samples, seeking discoveries at an atomic level.

Inside the Center for Autonomous Mining and Robotics, researchers can test autonomous systems in a simulated mine environment.

The Learning Theatre aims to be a space for learning, exhibiting, and socializing.

Students and faculty will take advantage of computational space on the fourth floor, which will allow for faster, more efficient development of new materials. Cutting-edge technology in the space will reduce the number of experiments needed to do so.

On that same floor, there will be labs dedicated to semiconductors, polymers, ceramics, and metals. Such spaces will be valuable for recruiting and retaining faculty members who conduct innovative research with global implications.

THE HOLDEN LEGACY LIVES ON

The legacy of Holden lives on in his grandson, **John G. Rocovich, Jr.**, '66, a graduate of the Pamplin College of Business and former rector of Virginia Tech's Board of Visitors. Rocovich has made Virginia Tech a central focus of his life. In 1987, Rocovich arranged a gift that endowed two departments in the College of Engineering—the Harry Lynde Bradley Department of Electrical and Computer Engineering and the Charles E. Via, Jr. Department of Civil and Environmental Engineering. Each year, the growing return from the endowment funds several dozen undergraduate and graduate scholarships and fellowships for both programs.

Photo: Logan Wallace; Drawings: Moseley Architects / SmithGroup

DRONE HOME: Undergraduate students and drone park interns Mohsen Roghanizad, Luis Pol, and Emily Pence operate a drone inside the drone park.

If we build it, they will come

Virginia Tech's drone park gives new pilots a place to learn—and experienced ones a place to innovate.

by ELEANOR NELSEN

By late fall 2017, all 20 steel poles were anchored 17 feet underground by truckloads of concrete; golf netting was stretched between them; heavy-gauge guy wires pulled the panels taut.

But before Virginia Tech's new drone park could open, there were final inspections to do.

And Kevin Yu was waiting.

"We kept asking, 'Is it ready? Is it ready?' One day the guy in charge sent us an email saying 'It's ready,' and I was like, 'Great, because I have something to do,'" Yu recalls. "We were in there the day after."

Yu is a third-year doctoral student in electrical and computer engineering. With his advisor, assistant professor Pratap Tokekar, he has been working on a pair of autonomous vehicles: a drone and a ground vehicle. Fine-tuned navigation and communications systems guide the drone to land on its ground-based partner and recharge, breaking up a long surveillance or inspection task into smaller chunks that are manageable for the aircraft's battery. Yu had been testing the system at Kentland Farm, some 10 miles away from campus; the drone park, tucked around the bend in Oak Lane where the golf course looks onto quiet pastures, would make his work much easier.

He wasn't the only one keeping an eye on the park's progress. Wm. Michael Butler, an associate professor of practice in the Department of Engineering Education, teaches one of the design courses required for first-year engineering students.

Researchers can test prototype aircraft and run ambitious experiments that lie beyond the narrow, conservative scope of operations permitted in the open; novice pilots can practice their skills.

A former aircraft configurator for Lockheed Martin and an avid amateur aviator, Butler challenges his students to build a drone that could be used to deliver medical supplies in remote areas.

The park's first few weeks saw the earliest flights of those homemade foam-board aircraft, a few of which glided smoothly all the way down the park's 300-foot span. The next semester, Butler scaled up the project for the larger spring class of 790 students. "It becomes a production," he laughed.

Greg Calvert, who manages the park, has worked alongside Yu and Butler. Today, he's the safety officer for the Virginia Tech Mid-Atlantic Aviation Partnership. But Calvert spent 27 years as a pilot in the U.S. Army, where he developed a knack for shepherding experts in other fields into the rigorous, heavily regulated, and occasionally byzantine universe of aviation. Now he uses those skills to help students, faculty, staff—and really anyone who walks in the park's doors—become pilots.

TALLEST PARK
Located just past the Duck Pond on the Virginia Tech campus, the 85-foot-tall drone park is the tallest in the United States.

The drone park is a made-to-order setting for that metamorphosis. Its net hems in any errant aircraft and exempts the park from strict Federal Aviation Administration regulations that govern flights in open airspace. Inside its boundaries, researchers can test prototype aircraft and run ambitious experiments that lie beyond the narrow, conservative scope of operations permitted in the open; novice pilots can practice their skills.

That Virginia Tech is now home to

the country's tallest drone park is just the latest superlative in a long tradition of autonomous systems research. The Virginia Tech Mid-Atlantic Aviation Partnership, which spearheaded the park's construction and runs its operations, also leads two major federal programs that further drone integration, with a portfolio of high-profile partners like Wing, State Farm, and NASA. The drone park helps extend Virginia Tech's national leadership in drone research, operations, and policy to an even broader group of students and faculty.

Yu's team and a handful of Butler's students had cameo performances at the park's official opening ceremony this spring, where Virginia Tech President Tim Sands presided and a drone flew a victory lap around the park's 85-foot-high ceiling, the ceremonial ribbon fluttering behind it. Activity hasn't let up: Student and faculty researchers, the university's top-ranked drone-racing team, local tech companies, and national organizations have all booked time on the park's calendar. Outreach events have brought in a new school or summer camp almost every week.

"Seeing the incredibly intelligent, amazingly curious, energetic students gives me a new perspective," said Calvert—who, in between flight training, fields calls from other universities asking for advice on launching similar programs.

One weekend, a couple of students walked up to the park's adjacent lab and knocked on the door—they'd just bought a new drone, and had heard they could use the park. Absolutely, Calvert told them. "They spent three hours in there, learning how to fly," he said.

"What's the movie—if you build it, they will come? We built it, and they're coming." ■

READY TO FLY
Kevin Yu, electrical and computer engineering doctoral student, holds a drone he flew at the drone parks' grand opening on April 26, 2018.

Photos: Erica Corder

Phishing for information

A computer science assistant professor is working to thwart increasingly dangerous email phishing attacks. by AMY LOEFFLER

Every email user has likely heard of the age-old email scam: A prince from another country needs your help and will pay handsomely—all he needs is your bank account number.

But the original 90s email scam has gotten a chilling update: Hackers can now hijack your email address and send emails from your address to your personal contacts. Neither you nor the recipient will know.

Gang Wang, an assistant professor of computer science is meeting the challenge of security breaches due to these socially engineered phishing attacks head on. He is designing novel techniques, combining both human intelligence and machine learning to combat real-world phishing attacks.

"Right now, automated detection systems run by algorithms tend to let questionable emails go through because false detections can be costly to users," said Wang. "Think about all the email you receive in a day and how frustrated you would be if you were constantly missing important messages."

Wang hopes to combine the nuance of human understanding in the smaller amount of emails that are questionable and develop techniques to help machines more easily uncover new attacks while maintaining the reliability of the system.

The crux of the email phishing problem is twofold. While machines are excellent at combing through huge amounts of data, they are not good at detecting nuanced cues humans could readily detect. Secondly, no matter how sophisticated the machine learning models are, advanced machine learning models only use historical data and are ineffective at detecting new threats that invariably pop up. It could only take one or two emails to breach a large system.

Wang's project has three broad goals: develop new measurement tools to automatically diagnose vulnerabilities in the existing phishing defense for email and social network systems; create novel machine learning interpretation techniques to drastically enhance users' ability for phishing detection; and identify new crowdsourcing methods to produce reliable, real-time phishing alerts.

Preliminary results showed carefully crafted phishing emails can penetrate most existing defenses, including Gmail, Outlook, and iCloud, leaving users exposed to phishing without any warnings. Wang based his findings on a scanning of 1 million domains and a penetration test on 35 email services.

Wang will study the effectiveness of his techniques using automated methods to block the massive phishing attacks with clear malicious signals while delivering the small portion of uncertain messages to users for further investigation.

To improve the ability of users to detect phishing, Wang will investigate fundamental techniques to translate machine learning results to human-interpretable semantics to assist users' decision-making. The crowdsourced user results will then be aggregated to produce real-time phishing alerts for the broad Internet community.

While the cyber underbelly of phishing scams is scary uncharted territory for many large institutions and shows no signs of disappearing, Wang is helping unsuspecting email users from ever being hooked. ■

Illustration: Justin Renteria

Students develop life-saving device

A student-run biomedical design organization developed a device for first responders to lift heavy patients—and save emergency medical workers from threatening injuries. by STEPHANIE KAPLLANI

This past March, Andy Cohen was caught in one of the worst snowstorms of the year. The Crozet, Virginia, native who graduated in May with a mechanical engineering degree was on his way back to Blacksburg from touring graduate schools when his flight from Charlotte to Roanoke was canceled.

He and several other strangers, all anxious to get home, decided to rent a car—which Cohen says was mistake number one. Mistake number two was deciding to take an alternate route.

"At first, everything was fine, the route was relatively clear. Then the snow started accumulating, and eventually we were driving in tracks through five inches of snow, so we decided to turn around. That was mistake number three," Cohen said, laughing.

Ultimately, in an attempt to reverse their course, the group ended up stranded. After exhausting all options to free the car from the snow and deeming the conditions too dangerous to travel in, Floyd County Rescue Squad housed the five individuals overnight at their station, in addition to providing them with hot showers and food.

Coincidently, Cohen was part of an extracurricular biomedical design organization called Bioactivity that was working on a device to help emergency medical service workers lift heavy patients.

"I said 'Hey, wait a second, I'm working on this EMS project, maybe you'd be interested in it?' So after making friends with the people there, I ended up talking to one of the station chiefs and she was really excited about the project," said Cohen, who is now working on a Ph.D. at Harvard University.

"She invited us back for a demo and a month later, we went back with a full fledged prototype."

The device, called the Emergency Lift Assist, was designed by a Bioactivity subteam called Cascade Rapid Response. The team, advised by Eli Vlaisavljevich, assistant professor of biomedical engineering and mechanics, primarily focuses on the design and implementation of devices to assist first responders and improve patient safety. The Emergency Lift Assist operates by safely and quickly rolling a patient onto a tarp. Once strapped in, a hydraulically powered set of frames lifts the patient with just the push of a button. The device can also fold to navigate tight spaces and traverse staircases.

Although emergency medical service workers have devices to transport patients, lifting them off the ground is another challenge entirely. This device reduces the wait time to load heavy patients by not having to call for extra labor and reduces the risk of injury on emergency medical service workers transporting these patients.

According to data from the National Institute for Occupational Safety and Health's Division of Safety Research,"overexertion and bodily reaction" is the most common injury emergency medical service workers face annually, typically making up between 30-40 percent of all diagnosed injuries. Within that percentage, almost 50 percent of "overexertion and bodily reaction" injuries are linked to lifting patients.

Floyd County Rescue Squad was especially grateful for the students' interest in helping them through the implementation of this device.

"The [Bioactivity] team was super to work with and very intelligent and flexible, especially since they asked us for pros, cons, and suggestions," said Ann Boyd, 1st lieutenant personnel for Floyd County Rescue Squad. "Once it is closer to completion, we agreed to have them come back to take another look."

Throughout the design process, Floyd County Rescue Squad "didn't sugarcoat" their feedback, which ultimately resulted in a better product, said Rachel Molloy, a senior from Queensbury, New York, studying mechanical engineering. The rescue squad also made clear their appreciation for the students working on this project in the first place.

"When we did the demo in front of Floyd Rescue Squad, one of the first things that they said was that they were so happy that we were thinking of them," said Molloy.

"The EMS market is very underrepresented and they were so excited that we weren't just making a device for a hospital, but we were making it to make their lives easier. The focus is really on the first responders."

That focus and ability to meet with the people whose lives could be changed by the technology ultimately resulted in a major lesson for the budding engineers.

"The biggest takeaway was how a single sit-down with your key market segment can really change the outcome of your project. It set on us on a couple of new paths that we are excited to pursue," Cohen said.

Bioactivity's goal is to have the device completed by the end of the year. Last year, the student-run group won $5,000 from a pitch competition held by entrepreneurship development organization The Launch Place in Danville, Virginia. Still, the limited time and resources the students have present major challenges in the implementation of the device.

Despite this, the team feels that this project and being on the Bioactivity team has greatly changed their career trajectories.

Molloy started at Virginia Tech as a pre-med student, but quickly realized her passions lie in helping others through engineering.

"This is everything I've ever wanted to do with engineering," Molloy said. "I am designing, working in a team environment, and bouncing ideas off others. When you have a team behind you that believes in the same thing with a common end goal … we're putting our heads together to come up with the best design—it's one of my favorite parts and what I love about engineering." ■

SAVING LIVES
Members of the Bioactivity team demonstrate their prototype and ask for feedback from first responders on the Blacksburg volunteer rescue squad.

Photos: Peter Means

Overexertion and bodily reactions are the most common injuries EMS workers face annually, typically making up between 30-40 percent of all diagnosed injuries.

GOOD VIBRATIONS
A group watches as the new shaker table is demonstrated in the Advanced Vibrations and Acoustics Lab.

Shaking up a lab

Alumni are helping Virginia Tech establish a lab that aims to be a leading international vibrations research lab. by ERICA CORDER

When you buy a mobile phone, you might not think about how far it's traveled to get to your pocket. You might think even less about the vibrational forces that acted upon it along the way.

In the Advanced Vibrations and Acoustics Lab, founded and directed by mechanical engineering professor Pablo Tarazaga, researchers are poised to make inroads determining standards of how much vibration an object can take.

The lab's goal is to certify the structural integrity of objects from cell phones to car parts to military equipment. With the help of alumni who work at the U.S. Naval Surface Warfare Center at Dahlgren, the lab was loaned new equipment that will make that earth-shaking research possible.

The equipment is a 2,000-pound, navy blue shaker table located in the lab's first floor space in Durham Hall. The shaker table can shake objects at frequencies as high as 4,000 hertz—meaning the researchers can recreate a wide array of real-world conditions in the lab.

Shock and vibration technical expert and alumnus Luke Martin (M.S. '04 and Ph.D. in mechanical engineering '11) orchestrated the loan from the Navy.

"We use shakers as a tool in our field to basically qualify equipment in weapon systems to go out in the fleet, and this was a shaker that we had that we really weren't using," Martin said. "We thought under our educational partnering agreement with Virginia Tech that we can essentially loan it down to Virginia Tech indefinitely, and they can get really good use out of it."

The partnership advances a plan to ultimately unite Virginia Tech, other universities, government, and industry in the creation of a vibrations and adaptive structures consortium that Tarazaga and other involved engineering faculty hope to base in Blacksburg.

The move would position Virginia Tech central to an international movement to develop standards of environmental testing. Instead of certifying objects by vibrating them until they break, the consortium would develop a certification framework that assists in the design stage.

For the Navy, that could help ensure the safety of equipment deploying on-board a ship. One day, it could help when designing rockets, which are subject to extreme vibrational forces. And for the rest of us, it might mean our fragile phones are shipped with a little more care, so they arrive as pristine as when they were manufactured. ■

Photo: Erica Corder

What do bubbles, cells, and dancers have in common?

Virginia Tech engineers have teamed up with a choreographer for a radical, creative approach to visualizing microscopic acoustic phenomena. by EMILY ROEDIGER

With an empty stage as her backdrop, one dancer pulses out into the light, her long hair swishing against her back in time with the music as she dips and weaves to an up-tempo beat. She's joined on stage by more dancers, who bob together, form clusters, and march together in lines.

The result of a Virginia Tech collaboration between Shima Shahab, an assistant professor in the Department of Biomedical Engineering and Mechanics, and Billie Lepczyk, a professor of dance in the School of Performing Arts, this dance has been designed according to one simple—if unique—guiding principle. The movement of dancers on stage is meant to mimic the "dancing" movement of tiny gas bubbles that have been stimulated by acoustic waves within a microfluidic channel.

The choreography not only helps engineers better visualize the microscopic bubbles' dancing phenomena, but it could also inform advancements in acoustic cell sorting, a field that has shown promise in developing noninvasive treatments for diseases like cancer.

It was that sense of potential that first led Shahab to reach out to Lepczyk last year. In the lab, Shahab and Marjan Bakhtiari-Nejad, an engineering mechanics doctoral student, and Ahmed Elnahhas, a then-undergraduate in the mechanical engineering program, had been experimenting with using ultrasound waves to manipulate materials within microfluidic channels, which are tiny chip-like structures that can be used to control liquids and other substances on a sub-millimeter scale.

When the researchers streamed acoustic waves across fluid in the channel, they discovered that the behavior of bubbles—which had been introduced into the channel at regular intervals—suddenly changed. The bubbles clustered together in interesting patterns, bobbed around one another, and moved in tandem. Almost like a dance.

Shahab discussed the implications of acoustic sorting and manipulation with colleague Rafael Davalos, the L. Preston Wade Professor in the Department of Biomedical Engineering and Mechanics.

"I found her research fascinating," said Davalos, who has a background in using microfluidic devices to isolate rare cell populations, particularly in brain cancer. Together with Shahab, he began thinking about using acoustic sorting in his work with cells, an area of research first pioneered at the Massachusetts Institute of Technology in 2016.

"Usually when you come up with a solution, you're rarely working on the actual problem," said Davalos of the choreography. "You just need to take a step back and think about it from a different angle."

For engineers who work on incredibly complex problems and systems, often under a microscope, radical approaches that challenge assumptions can often lead to the next breakthrough. For the skeptics who think biomedical engineering and dance may be an unlikely pairing, Shahab said it's all about changing your perspective. ■

Illustration: Chris Gash

THE POWER OF TWO
Within a week of becoming friends, alumni Rob Wallace and Walter Barnes were making plans on future entrepreneurial ventures. Fifteen years later, they're realizing the vision with a unique project in the clean energy sector.

The transformers

Two engineers collaborate on a clean energy company that provides employment for underserved people in the Baltimore area. by ERICA CORDER

Rob Wallace '00 and Walter Barnes '00 first met the summer before their freshman year at Virginia Tech, in 1996. Ask them to tell you how, and they both laugh.

"He used to rollerblade," Barnes says.

"I still rollerblade," Wallace interjects.

"I went rollerblading last night."

"He still rollerblades," Barnes says, laughing. "Which I thought was very odd."

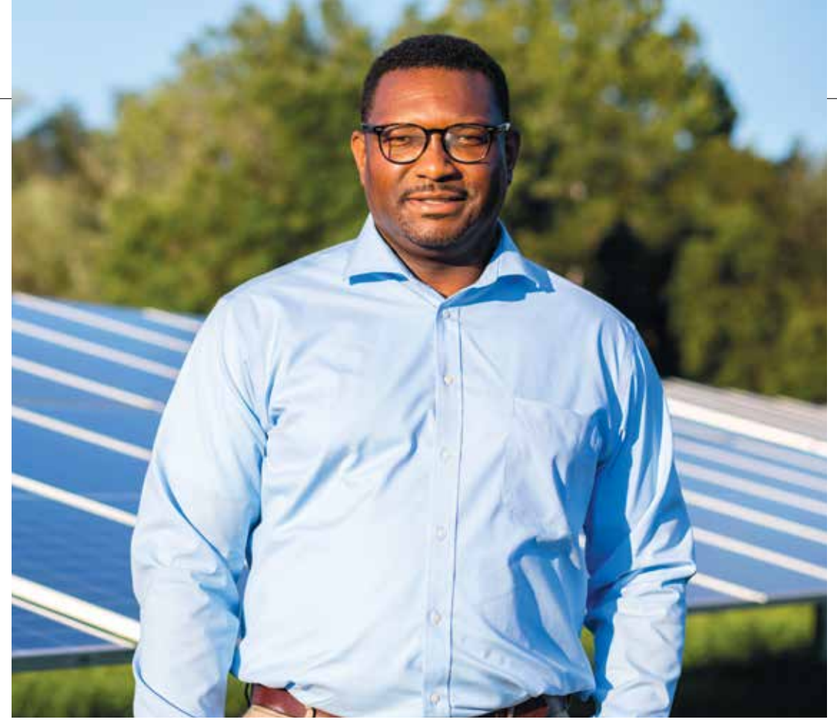
That first summer, the pair adjusted to college life together through ASPIRE, a summer program now called Student Transition Engineering Program, run by the College of Engineering's Center for the Enhancement of Engineering Diversity.

Within their first week of friendship, the pair were making plans together on future entrepreneurial ventures. Both of them wanted to own companies some day and believed in the same goals: "to be successful, bless God's kingdom, and help people," Wallace explained.

"I remember that first conversation, like, 'Man, we're going to start a company together one day,'" said Barnes, a Grado Department of Industrial and Systems Engineering graduate. "It wasn't even a question. And so, to have someone that kind of thought the same way and viewed the world the same way—because it is a perspective thing—is refreshing, and you know that you're kind of in the battle together."

In 2015, 19 years later, that battle became breaking the cycle of poverty, unemployment, and incarceration in Baltimore, Maryland.

That April, the death of 25-year-old



Freddie Gray—an African-American man from Baltimore who died of injuries sustained while in transit in a police vehicle—spurred days of protests in the city.

In the aftermath, Baltimore-native and real estate executive Cherie Brooks felt compelled to bring positivity to her hometown. She jumped on a call with two like-minded locals: Wallace and Ray Lewis, a former linebacker for the Baltimore Ravens.

With Wallace's expertise in solar energy development, the group crafted a plan to provide opportunities for community workforce development in the solar energy sector. So began a company that would provide solar photovoltaic installation training and employment for at-risk adults, returning citizens, and underserved individuals living in and around Baltimore City.

Over several weeks, the program's trainees learn to install solar panels on community and agricultural facilities and commercial rooftops—driving further development of sustainable, clean energy in Maryland. Because of a global push toward renewable energy, the company's technical education provides trainees with a valuable skill set in a growing industry. Meanwhile, the company's focus on education in life skills like financial literacy make inroads in trainees' lives outside of work.

A twofold mission like this is especially important in a city where nearly a quarter of residents live in poverty—about double the national average—according to the U.S. Census Bureau.

They decided to call the venture Power52 Foundation, leveraging Lewis' football jersey number. But before they could move forward, Wallace and his co-founders needed a chairperson of the board for the foundation.

"I said, 'Who is aligned with this mission, who do I trust with my life, and who has the same values that we have and is going to want to pour into people's lives?" Wallace said. The answer was simple: "Walter Barnes."

Barnes, who is president of PM Consulting Group and is also chair of another foundation started by fellow Hokie Eric King, initially wasn't sure he'd have time.

> "To have someone that kind of thought the same way and viewed the world the same way—because it is a perspective thing—is refreshing, and you know that you're kind of in the battle together." —Walter Barnes on his friendship with Rob Wallace

"But when your friends want you involved in something,—and I know him, he's very passionate, I'm passionate—you make time for that. That's important," Barnes said.

So began a transformative company that has, to date, trained over 100 people of all backgrounds, giving them access to a better quality of life, and provided 30-megawatts of solar projects that will produce 40,000-megawatt hours of clean energy for 2,500 middle- and low-income households. For Wallace and Barnes, it's been a rewarding three years.

"You couldn't have planned it this way," Wallace said.

As fortuitous as the complementary relationship between Barnes and Wallace may seem, they both agree the wheels were set in motion at Virginia Tech, through the efforts of the Center for the Enhancement of Engineering Diversity and its director, Bevlee Watford.

During the summer program the pair attended, they met dozens of other engineering students in an environment designed to encourage camaraderie.

"You take that whole buffer out when you first come to college," said Wallace, an electrical engineering graduate. "One of the things Dr. Watford did, which I think was critical for me, was she created an environment of partnership early."

For Barnes and Wallace, the ingredients for a strong relationship were already there in their personalities alone: Barnes, with his quiet resolve and reflective temperament, complements Wallace, whose charisma and boldness render him a perfect spokesperson for a company with an operating model so markedly unique. But the close-knit environment fostered by Watford made it that much easier for the two to connect, they say.

Now, 22 years since the summer Wallace rolled into Barnes life, they're known to each other's children as uncle. When they can, they like to come back to the place in the mountains where it all started. They even give back to Virginia Tech together, building an endowment that they hope will tackle issues of representation at the university by providing access to scholarships for more underrepresented students.

Their timing is advantageous: The 2017 installation of the new dean of the College of Engineering, Julia Ross, has ushered in a heightened focus on inclusion and diversity. Ross' inclusive excellence vision actively prioritizes the recruitment and retention of students of all backgrounds, citing the need for every bright mind at the table to solve the transdisciplinary, complex problems of the 21st century.

The historic foundation and infrastructure laid by Watford's leadership and through CEED allow for such advances—and it has since the days Wallace and Barnes first came to summer camp.

Irrespective of how far Wallace and Barnes have come since then, one thing remains the same. Just as he didn't two decades ago, Barnes still doesn't get the whole rollerblading thing.

"For the record, I'm not doing that," Barnes says.

"Never. He wouldn't even try," Wallace says. "I had an extra pair." ■

DYNAMIC DUO
Left: Walter Barnes, industrial and systems engineering '00

Below: Rob Wallace, electrical engineering '00

Photos: Erica Corder

GAME CHANGER
Electrical engineer Paige Kassalen, '15 was on the ground crew of Solar Impulse, the first airplane to circle the globe powered by the sun. At 22, Paige was the youngest member and only American on the ground crew.

Full speed ahead

From planes to cars, there's no stopping 25-year-old alumna Paige Kassalen, who made history with the world's first solar-powered flight. by STEPHANIE KAPLLANI

One year after graduating from Virginia Tech, Paige Kassalen '15 was the youngest person responsible for the takeoff and landing of the Solar Impulse, the first solar-powered plane to make a trip around the world. Of the 16-person crew, she was the only American and one of two women involved.

It's no surprise, then, that one year after her journey with Solar Impulse, Kassalen made the *Forbes Magazine* "30 Under 30" list, which annually profiles 600 of what the magazine calls the "brightest young entrepreneurs, innovators, and game changers."

"That was a moment where your heart drops and you're just so confused about how you achieved this career goal that you didn't know would actually be possible," said Kassalen, who was also featured in *Teen Vogue*.

"When I was asked to join the Solar Impulse team, I was scared that I didn't have enough experience, but that was not going to stop me from doing this once-in-a-lifetime job. It was just like the projects I would do at Virginia Tech: We would learn techniques to problem-solve, but it's not like there was a magic solution that could tell you the answer," Kassalen said. "There was no textbook for Solar Impulse, but there was definitely a lot of problem-solving and I was an expert at that after my studies at Virginia Tech."

The skills that she developed at Virginia Tech and Solar Impulse provided the foundation for the past three years she's spent at Covestro, a raw materials supplier and manufacturer. Kassalen is working on identifying and developing high-performance materials that will withstand the wear and tear of hundreds of people getting in and out of autonomous vehicles built for ride-sharing purposes.

Teaming up with chemists, Kassalen now leads projects developing new materials, anywhere from lightweight electric vehicle battery packaging, to creating coatings for autonomous vehicle sensors in order to improve visibility.

She believes that autonomous vehicles will be "the biggest technology revolution of our time."

According to Kassalen, this is because autonomous systems and vehicles are one way to provide equal access to mobility for everyone.

"When vehicles are autonomous, electric, and shared, the cost per mile could be much cheaper than owning a car, which opens doors for people who struggle to find jobs because of transportation," Kassalen said. "Job opportunities are not the only reason people need to travel: some people don't have access to grocery stores or health care. Autonomous vehicles could be purposefully built to be a grocery store on wheels or a pharmacy on wheels."

In addition to working on autonomous vehicles, Kassalen hopes to soon pursue an MBA, start her own company, and give back to Virginia Tech however she can.

"I really feel like I am who I am today because of my experience at Virginia Tech, and I want to thank them for that," she said.

Kassalen was recently elected to be on Virginia Tech's Bradley Department of Electrical and Computer Engineering Industrial Advisory Board. She is no stranger to juggling multiple leadership roles while simultaneously giving back to her community through volunteer work.

In addition to staying on top of her coursework throughout her undergraduate years, Kassalen was a departmental ambassador who gave tours every Friday, president of the Virginia Tech student chapter of the Institute of Electrical and Electronics Engineers, on a design team, vice president of public relations for the Tri Delta sorority, led the development of the Solar Powered Derby for the Blacksburg Cub Scouts, on the homecoming court, and a member of the Scuba Club at Virginia Tech.

"No one is one-dimensional. I wasn't just an electrical engineer," Kassalen said.

Still, she knew why she was an electrical engineer in the first place, and advises other prospective engineers to find their motivation before jumping into the rigorous coursework and demanding field.

"If you are considering being an engineer, really figure out exactly why," Kassalen said. "I remember being so upset about a class and talking with my mom on the phone. She asked, 'Do you want to switch majors?' And I replied, 'Are you kidding me? No way! What else would I do? This is what I am passionate about and I'm not just going to give up.'"

Many of her classmates tried to tell her that she was doing too much or that she shouldn't be so involved in certain things, especially as her classes progressively became harder.

Kassalen's response? "The biggest key to success will be to surround yourself with a support system of people telling you that you can do it."

"I am motivated by the idea that I can actually make a difference. The driver for that is that I, again, have a support system believing in me and telling me I can do it. I always feel like I am a part of something bigger than myself, and I always feel like I will be representing Virginia Tech and the College of Engineering," Kassalen said. "I want to keep pushing myself to achieve the future my support system there knows that I am capable of." ■

MAKING THE CUT
Kassalen is listed on Forbes' "30 Under 30" one year after the Solar Impulse journey.

VR FOR REAL
Kassalen testing out a virtual reality autonomous vehicle.

AIRBORNE
Kassalen works on the Solar Impulse Project.

Photos: Courtesy of Paige Kassalen

GIVING BACK: The May Family

Gift creates a pathway for first-generation engineering students

Thanks to the May Family Foundation, more doors have been opened for Virginia high school students to attend Virginia Tech. by ERICA CORDER

When electrical engineering alumnus Joe T. May '62 was in high school, he says he wasn't exactly on a path to success. But it was guidance from "a couple of people in small ways" that enabled him to earn an electrical engineering degree from Virginia Tech.

It's one of the reasons May and his family—including his wife, Bobby, and two daughters, Virginia Tech alumna Elaine and University of Virginia alumna Beth—have gifted the College of Engineering $5 million from the May Family Foundation to establish a multiyear program that aims to increase the number of first-generation students in Virginia who enroll at and graduate from Virginia Tech in engineering.

Since the gift was announced last May, the Center for the Enhancement of Engineering Diversity has begun laying the framework of the program, which will rely heavily on partnerships with high schools across Virginia and Virginia Tech's College Access Collaborative, a university effort to increase academic preparation, access, and affordability of college for underrepresented groups.

The first cohort of 10th, 11th, and 12th graders apply starting January 2019. A total of 180 high school students in the first group—60 from each grade level—will be admitted in spring and invited to campus in summer for engineering-related programming, followed by one visit each semester and summer until they graduate high school.

Support continues throughout college. If students are accepted to and enroll in engineering at Virginia Tech, that support takes the form of living-learning communities and scholarships that fund study abroad and extracurriculars.

Over the duration of a five-year pilot, this program should provide 300 students with the gateway to successfully pursue engineering degrees. ■

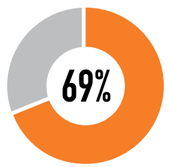
Photo Courtesy of the May Family Foundation

Giving Day: An outpouring of philanthropy

On March 20, 2018, Virginia Tech held an inaugural Giving Day, a 24-hour online fundraising challenge that aims to rally alumni and friends of the university to raise money and awareness of the impact of philanthropy.

5,470
GIFTS
TOTAL TO VIRGINIA TECH

TO THE COLLEGE OF ENGINEERING
The most raised of any college



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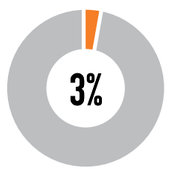
617 ALUMNI



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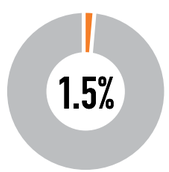
79 CURRENT FACULTY & STAFF



$4,200
from
36 PARENTS

801
DONORS

135
FIRST-TIME DONORS

GIFTS RANGED FROM **$5** TO **$100,000** AND SUPPORTED **343** DIFFERENT AREAS OF THE UNIVERSITY

GIVING DAY 2019

Hokies came together again for 24 hours starting on March 19, 2019 for our second annual Giving Day at Virginia Tech. Each gift provided further opportunities for study abroad, research, and hands-on learning for our students and supported impactful research.

We've been tallying the results — want to see how engineering stacked up this year? Check out the results and see the difference made by College of Engineering students, alumni, faculty, staff and friends:

bit.ly/COEgivingday19

Infographic: Complex Stories

CAMPUS OF THE FUTURE: This is a conceptual rendering. The image is not an actual representation of the Innovation Campus.

Virginia Tech Innovation Campus key to Virginia attracting Amazon HQ2

The $1 billion Virginia Tech Innovation Campus will be a global center of technology excellence, igniting the region's innovation economy.

After more than 200 localities across the country competed to win Amazon's HQ2 and its estimated 50,000 jobs, Virginia emerged as a winner in the nationwide competition to house a headquarters for Amazon. The state of Virginia also stepped up with a higher education package, including a new Virginia Tech Innovation Campus in Alexandria, which will be located less than two miles from Amazon's new location in Arlington.

"As a land-grant research institution, we knew we needed to claim our role of driving economic development in Virginia," said President Tim Sands. "Our new Innovation Campus will be the global center of technology excellence and talent production—where highly skilled students, world-class faculty, smart ideas, and forward-thinking companies will meet to propel the commonwealth and the region forward."

When fully realized, the $1 billion Innovation Campus will spark discoveries and help fill immense demand for high-tech talent in the greater Washington, D.C., area and beyond. The Commonwealth of Virginia and Virginia Tech have committed $250 million each to seed the project.

The spralling 1 million-square-foot urban campus will bring together hundreds of new graduate students, dozens of new faculty members, and numerous industry partners. As part of its plan to increase undergraduate enrollment to 30,000 students, Virginia Tech also will increase undergraduate enrollment by 2,000 students in computer science, computer engineering, and related disciplines at its Blacksburg campus over the next eight years.

"As one of the nation's top engineering programs, Virginia Tech already has the reputation and talent needed for an expansion as bold as this," said Julia Ross, the Paul and Dorothea Torgersen Dean of Engineering. "As we recruit and grow in Northern Virginia and Blacksburg, we will further demonstrate our excellence."

Virginia Tech is widely known for its long-standing excellence in computer science, engineering, data analytics, and technology. The College of Engineering ranks No. 8 in the nation for research expenditures, according to the National Science Foundation, and No. 13 for its undergraduate program, according to *U.S. News & World Report's* 2019 rankings. ■

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VIRGINIA TECH

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