VCU College of Engineering

# 2025

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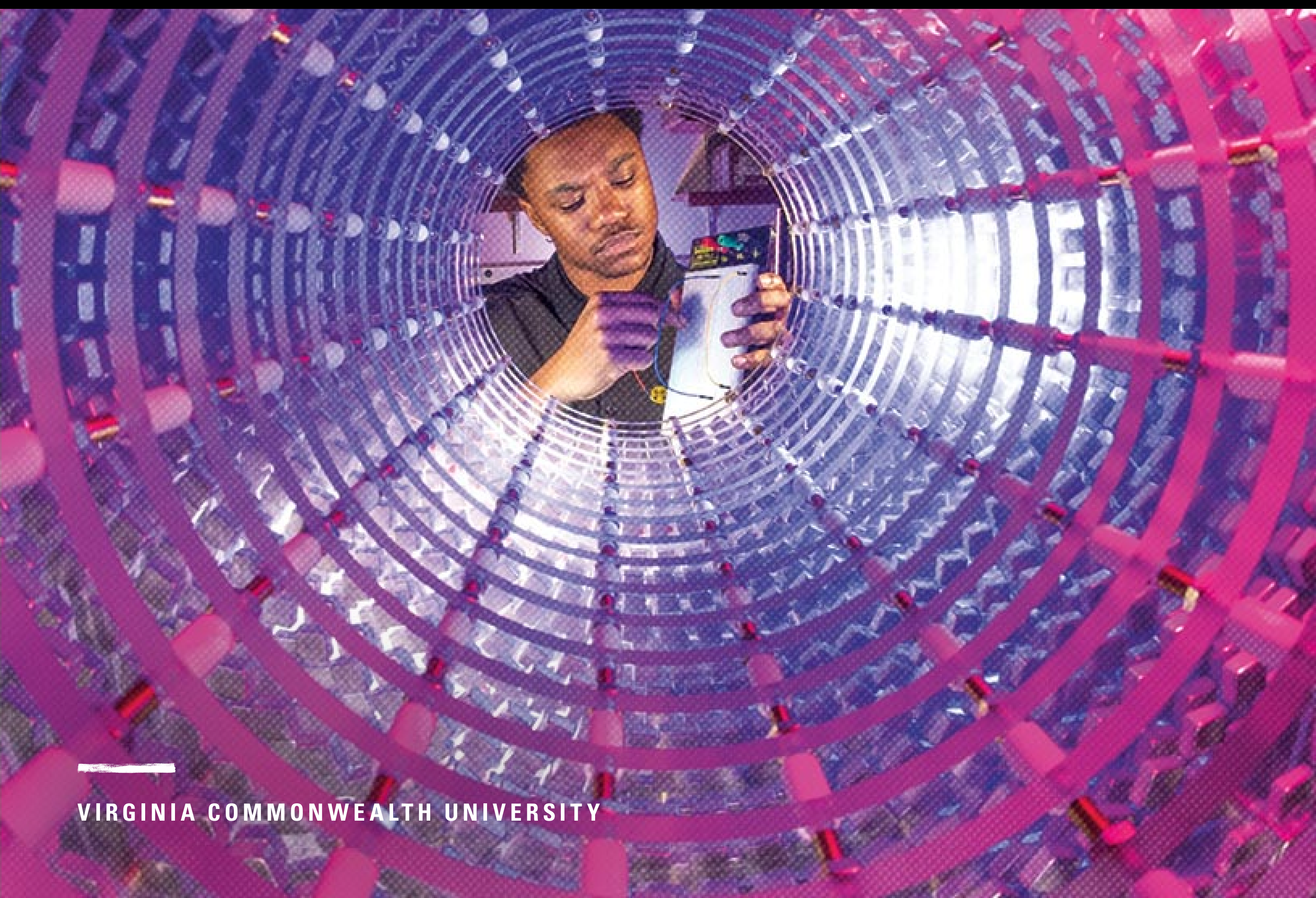

VIRGINIA COMMONWEALTH UNIVERSITY


# DISCOVERING SOLUTIONS. BUILDING TOGETHER. SERVING HUMANITY.

**STAFF**

**EDITOR**
Jennifer Pulver

**COPY EDITOR**
David Pulgar

**WRITERS**
Rebecca Antler
David Pulgar
Jena Salem

**PHOTOGRAPHER**
Shawn Jones
Daniel Wagner

**WEB DEVELOPER**
Dustin Kratochwill

**ART DIRECTOR**
Chereen Baramki

**CONTRIBUTORS**

Dan Carrigan
Beth Eberth
Emily Komornik
NASA
Madeline Reinsel
Olivia Trani
Leila Ugincius
Dina Weinstein
Teresa Whiting
TechTransfer and Ventures

A problem to be solved isn't an obstacle, it's inspiration. At the Virginia Commonwealth University (VCU) College of Engineering, students go beyond traditional engineering disciplines to discover, build and find solutions to humanity's most challenging questions. Engineering without boundaries, Rams develop skills to become and collaborate with experts who change the world. This is **Engineering for Humanity** and the story of our Ram engineers!

Read it online at
**egr.vcu.edu/magazine**

## INTRODUCTION



## 01 DISCOVERING SOLUTIONS



## 02 BUILDING TOGETHER



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## INTRODUCTION

Starting my third year as Alice T. and William H. Goodwin Jr. Dean of the College of Engineering at Virginia Commonwealth University (VCU), I reflect on the remarkable achievements of our faculty, staff and students. It has been a great opportunity and pleasure to serve this community of scholars. Our faculty and students exemplify the spirit of our Engineering for Humanity motto, which underpins everything we do. As engineers, we aim to make a positive impact in our communities and the world.

This approach is reflected in measurable gains across key academic areas. From rising enrollment and strong job placement for graduates to increases in research productivity, sponsored awards and groundbreaking discoveries, the VCU Engineering community continues to reach new heights while making a meaningful impact. This magazine highlights just a few of these accomplishments from the past academic year.

Leveraging the strength of interdisciplinary and cross-disciplinary research with the VCU School of Medicine, School of Pharmacy, VCU School of Arts and others, VCU engineers address the most urgent challenges of our era through partnerships that foster innovation and generate impact. For instance, faculty from the Departments of Mechanical and Nuclear Engineering, Biomedical Engineering and Pharmaceutics collaborated to develop a dry powder formula and a delivery device to help treat Infant Respiratory Distress Syndrome in low-resource settings. This project showcases our commitment to Engineering for Humanity — using knowledge and creativity to improve lives.

I am dedicated to expanding our capacity to innovate. We're creating new opportunities in critical fields — robotics and autonomous systems, power and energy, artificial intelligence, cybersecurity, pharmaceutical and additive manufacturing, and biomedical engineering. In just the past two years, the college has launched 14 new programs, many already generating strong student interest and early success.

For example, through a multi-year partnership with Dominion Energy, the Department of Electrical and Computer Engineering launched a Power Systems Engineering program to prepare engineers for the evolving energy demands of artificial intelligence, high-performance computing, and digital infrastructure.

In another significant effort, faculty from four engineering departments launched an interdisciplinary minor in robotics and autonomous systems engineering. A distinctive feature of this program is all robotics courses are project-based. New research labs have been created, and dedicated new faculty positions will help advance this field. These partnerships and collaborations are enhanced by shared resources, such as the High Performance Research Computing core facility, a campus-wide resource managed by faculty from the College of Engineering. It provides access to advanced technology for research teams across the university.

Our students are a vital part of this momentum. Undergraduate and graduate researchers take part in experiential learning opportunities that are a hallmark of the VCU College of Engineering. Among our four distinct experiential learning opportunities is a new industry internship for credit, which allows engineering students interning in relevant industries to earn six credit hours toward their degree program — a unique offering at the college.

Whether leading innovation in industry, advancing public policy or launching startups, our alumni are applying this education in meaningful ways around the world. Their success reflects the strength of a degree from the VCU College of Engineering. Our programs are increasingly recognized in national rankings, including those published by U.S. News & World Report.

I am grateful for the faculty, staff and students who make our success possible. The following pages offer a brief glimpse into a year marked by significant achievements. I invite you to explore these highlights and imagine what's next for our college and community.

Let's continue to discover, build and learn together.

**Go Rams!**

**Azim Eskandarian, D.Sc., Fellow of ASME & IEEE**
Dean, College of Engineering
Alice T. and William H. Goodwin Jr. Chair/Professor
Virginia Commonwealth University




# ENGINEERING OUR FUTURE

## STATISTICS FROM THE VCU COLLEGE OF ENGINEERING

### DEGREES AWARDED

**2,043** UNDERGRADUATE STUDENTS ENROLLED

**422** GRADUATE STUDENTS ENROLLED

### AFTER GRADUATION

**90%** UNDERGRADUATE STUDENTS WORKING IN DEGREE-RELATED FIELD

**$78,770** MEDIAN UNDERGRADUATE STUDENT STARTING SALARY

### SPONSORED AWARDS & STUDENT AID

**9%** INCREASE IN SPONSORED AWARDS FOR FACULTY

**636** PELL GRANT RECIPIENTS

**$16,770** AVERAGE PER-STUDENT UNDERGRADUATE AID

### UNDERGRADUATE EXPERIENTIAL LEARNING

**74%** PARTICIPATION IN EXPERIENTIAL LEARNING

**34%** UNDERREPRESENTED MINORITIES

**29%** FEMALE-IDENTIFYING

*Data sourced in part from VCU Institutional Research and Decision Support.*

INTRODUCTION

# RESEARCH PILLARS

## LIFESAVING THERAPY FOR PREMATURE BABIES

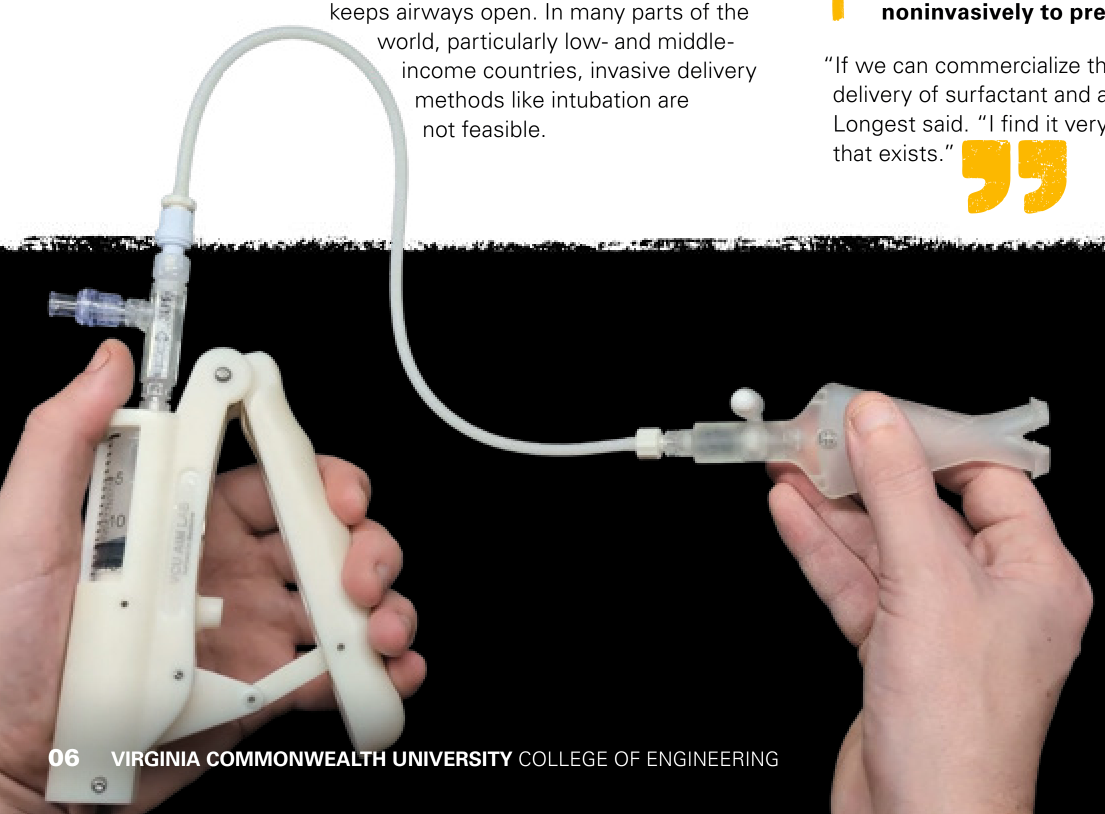
After multiple prototypes and more than a decade of collaboration, two VCU inventors are closer than ever to bringing a potentially lifesaving device to premature infants around the world. Their handheld dry powder inhaler for newborns in respiratory distress cleared a proof-of-concept milestone, with results published in a peer-reviewed journal. Now, inventors Michael Hindle, Ph.D. from the VCU School of Pharmacy and **Worth Longest, Ph.D.** from the VCU College of Engineering, are focused on clinical trials.

Premature infants born with underdeveloped lungs lack surfactant, a naturally occurring substance that reduces surface tension and keeps airways open. In many parts of the world, particularly low- and middle-income countries, invasive delivery methods like intubation are not feasible.

"We probably made maybe too many prototypes – [more] than we should have," joked Longest. "But because we have the 3D-printing technology, we can come up with an idea, turn it around and test it the next day. Over the years, it's been hard to put a number on it, but we're probably in the thousands."

**Their commitment has resulted in a low-cost, compact device that uses four simple squeezes to create a high-efficiency aerosol capable of reaching deep into a newborn's lungs – and without the need for electricity, intubation or a ventilator. That would allow health care providers to deliver lifesaving therapy quickly and noninvasively to premature babies.**

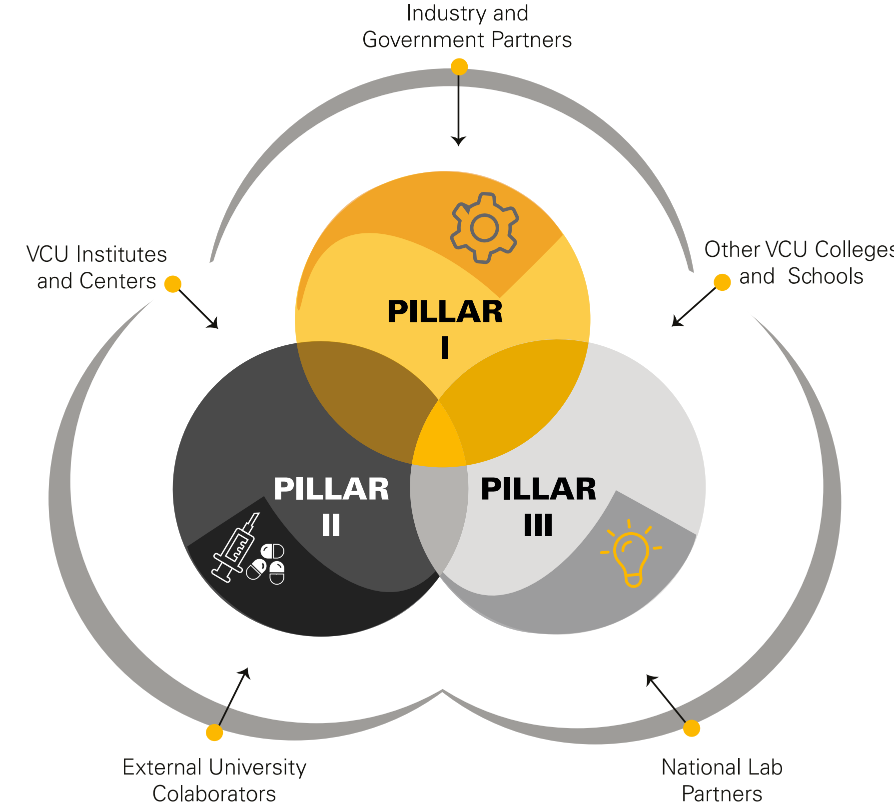
"If we can commercialize that technology, we can improve the delivery of surfactant and a number of other medications as well," Longest said. "I find it very rewarding, largely because of the need that exists."



*Using 3D-printed upper respiratory pathway models, Worth Longest, Ph.D. and his colleagues are able to test the effectiveness of their dispersal mechanism to ensure the dry powder formulation is disbursed in the necessary quantities.*



# RESEARCH CENTERS, INSTITUTES AND CLUSTERS




### PILLAR I
**AI, AUTONOMOUS SYSTEMS AND COMPUTING**

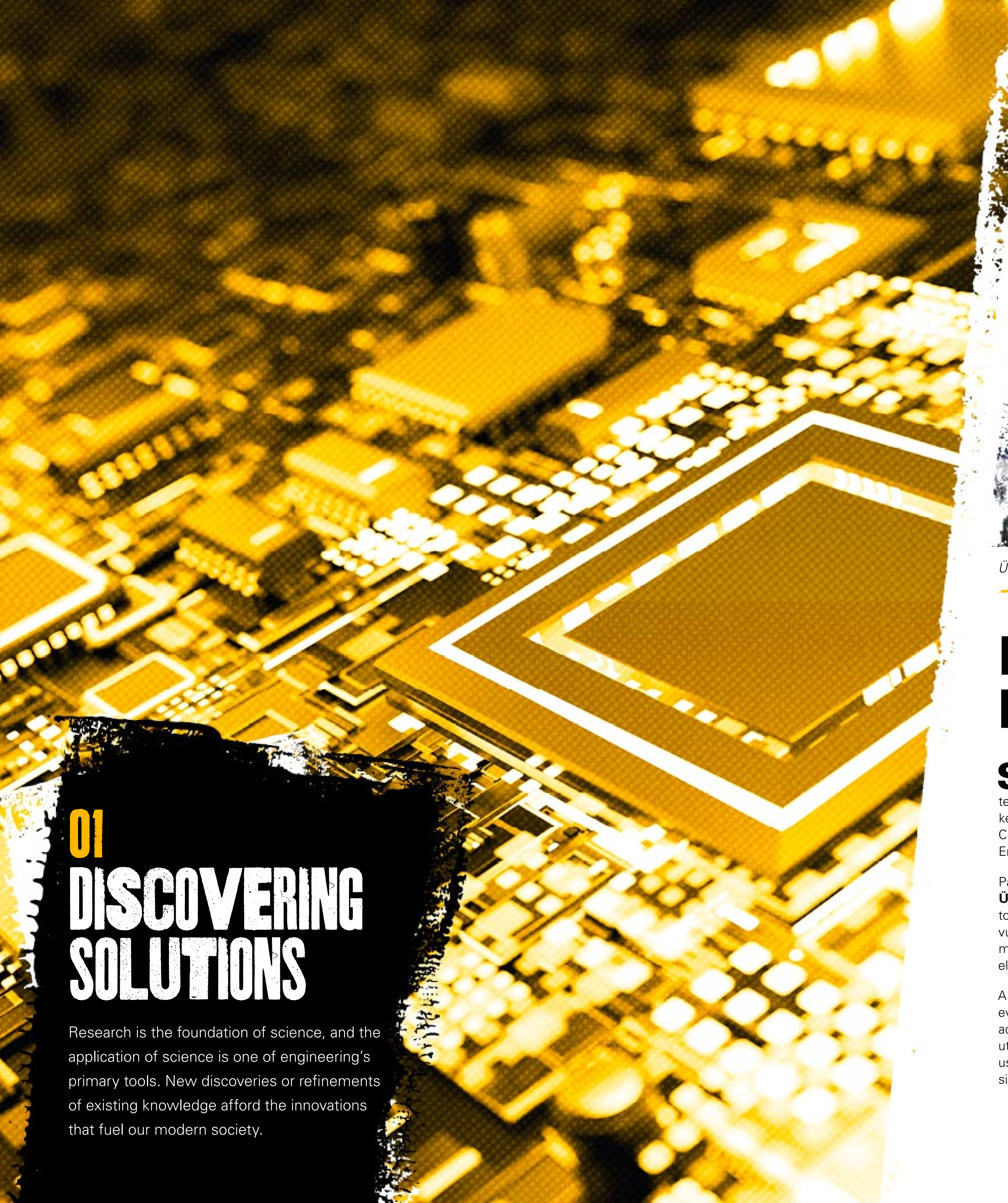
- Center for Analytics and Smart Technologies
- Commonwealth Center for Cloud Computing
- Commonwealth Cyber Initiative – Central Virginia Node (CCI)
- Convergence Lab (CLI)
- Cybersecurity Center
- Robotics and Autonomous Systems (RAS) Group
- Virginia Microelectronics Center (VMC)

### PILLAR II
**HUMAN HEALTH AND MEDICINE**

- Center for Excellence in Particle and Fiber Engineering (CEPFE)
- Center for Pharmaceutical Engineering and Science
- Institute for Engineering and Medicine (IEM)
- Medicines for All

### PILLAR III
**SUSTAINABILITY: MATERIALS, ENERGY AND ENVIRONMENT**

- Center for Rational Catalysis Synthesis (IUCRC)
- Institute for Sustainable Energy and Environment (ISEE)
- Materials and Manufacturing Research Center
- Nanomaterial Core Characterization Center (NCC)



01

# DISCOVERING SOLUTIONS

Research is the foundation of science, and the application of science is one of engineering's primary tools. New discoveries or refinements of existing knowledge afford the innovations that fuel our modern society.

*Ümit Özgür, Ph.D. (right), works on MEMS and NEMS logic solvers with a doctoral student.*

## HARDWARE-BASED SECURITY FOR CRITICAL SYSTEMS

Safety-critical systems are all around us – from everyday medical devices to aircraft control to the self-driving technology in your new car – these are the systems developed to keep us safe as technology advances. Researchers at the VCU College of Engineering's Department of Electrical and Computer Engineering are changing the way we develop these systems.

Parallel projects run by Professors **Carl Elks, Ph.D.** and **Ümit Özgür, Ph.D.** utilize physics-based hardware solutions to challenges where software poses significant security vulnerabilities. Instead of relying on software-controlled digital microprocessors, Özgür's team uses micro- and nano-electromechanical systems (MEMS/NEMS) as logic solvers.

Already prevalent in our society, MEMS and NEMS are in everyday items, from motion detecting in smartphones to advanced, high-precision biomedical devices. Özgür's team, utilizing this pre-existing technology, is developing devices that use electrostatic forces to move silicon actuators to perform simple logic operations.

Because hardware is the tangible, physical component of a system, it is harder to change than software; however, this restricted configurability is actually more favorable when applied to safety systems. Its immunity to cyber attacks, software design flaws and environmental hazards give hardware a much higher reliability than software systems.

While both Elks' and Özgür's research leverages hardware-based architectures in their solutions, Elks' project approaches the problem from a slightly different angle. Elks and his team saw the root of the issue was not just the software but the complexity within the systems and lack of awareness when designing them, prompting his creation of the SymPle technology.

Through this methodology, Elks and his team have built a highly-constrained digital hardware platform, the first known overlay architecture for safety-critical computing, embedded with only essential security and safety attributes. The SymPle overlay architecture can be implemented on a Field Programmable Gate Array (FPGA), which is a configurable hardware chip, or an Application Specific Integrated Circuit (ASIC), which is a hard-wired device built to perform specific functions.

> **WHEN IT WAS DISCOVERED THAT THESE BIOLOGIC PHARMACEUTICALS CAN HELP WITH WEIGHT LOSS, DEMAND SPIKED.**
>
> **MICHAEL PETERS, PH.D.**

*Te'Ahrian Tyler, a student researcher with Michael Peters, Ph.D., working with the radial flow bioreactor.*

# CONTINUOUS MANUFACTURING OF BIOLOGIC PHARMACEUTICALS

Chemical and Life Science Engineering Professor **Michael "Pete" Peters, Ph.D.**, is investigating more efficient ways to manufacture biologic pharmaceuticals using a radial flow bioreactor he developed. With applications in vaccines and other personalized therapeutic treatments, biologics are versatile. Their genetic base can be manipulated to create a variety of effects, from fighting infections by stimulating an immune response to weight loss by producing a specific hormone in the body.

Ozempic, Wegovy and Victoza are some of the brand names for Glucagon-Like Peptide-1 (GLP-1) receptor agonists used to treat diabetes. These biologic drugs mimic the GLP-1 peptide, a hormone naturally produced in the body that regulates appetite, hunger and blood sugar.

"When it was discovered that these biologic pharmaceuticals can help with weight loss, demand spiked," says Peters. "These drug types were designed for people with type-2 diabetes and those diabetic patients couldn't get their GLP-1 treatments. We wanted to find a way for manufacturers to scale up production to meet demand."

Continuous manufacturing improves efficiency and scalability by creating a system where production is ongoing over time rather than staged. These manufacturing techniques can lead to "end-to-end" continuous manufacturing, which is ideal for producing high-demand biologic pharmaceuticals like Ozempic, Wegovy and Victoza. Virginia Commonwealth University's Medicines for All Institute is also focused on these production innovations.

Peters' continuous manufacturing system for biologics is called a radial flow bioreactor. A disk containing the microorganisms used for production sits on a fixture with a tube coming up through the center of the disk. As the transport fluid comes up the tube, the laminar flow created by its exiting the tube spreads it evenly and continuously over the disk. The interaction between the transport medium coming up the tube and the microorganisms on the disk creates the biological pharmaceutical, which is then taken away by the flow of the transport medium for continuous collection.

Chemical and Life Science Engineering Assistant Professor **Leah Spangler, Ph.D.**, is an expert at instructing cells to make specific things. Her material science background employs proteins to build or manipulate products not found in nature, like purifying rare-earth elements for use in electronics.

Spangler is collaborating with Peters in the development of his radial flow bioreactor, specifically to engineer a microorganismal bacteria cell to coat the bioreactor disk that is capable of continuously producing biologic pharmaceuticals. Development of the process and technique to use E. coli with the radial flow bioreactor is ongoing.

Similar to how the GLP-1 peptide has found applications beyond diabetes treatment, the radial flow bioreactor can also be used in different roles. Peters is currently exploring the reactor's viability for harnessing solar energy. The radial flow bioreactor can also be implemented for environmental cleanup. With a disk tailored for water filtration, desalination or bioremediation, untreated water can be pushed through the system until it reaches a satisfactory level of purification.

**Read the full story to see the radial flow bioreactor in action.**

DISCOVERING SOLUTIONS

# STUDENT RESEARCH


*As part of the Fluids in Advanced Systems and Technology research group, mechanical and nuclear engineering major Jeremy Lopez studies and tests pumps that use air under pressure to move water through pipes, a technique that could be more efficient than using conventional pumps at nuclear power plants.*

## BETTER PUMPS FOR FUEL REPROCESSING

Jeremy I. Lopez began his research journey in the Fluids in Advanced Systems and Technology (FAST) research group, led by **Lane Carasik, Ph.D.**, an assistant professor in the College of Engineering. Exploring computational and experimental thermal hydraulics, FAST focuses on advanced nuclear reactor technology, fusion-enabling technology and concentrated solar power plants that involve molten salts and high pressure/temperature gases, such as helium.

Lopez's undergraduate project involves researching and building a Jet Pump Pair — JPP for short — a special kind of pump that uses air to move water through tubes.

"Kind of like blowing through a straw to suck up water," he explained. "It uses air under pressure — like blowing really hard — to suck up and move water or other liquids through a pipe. It doesn't have any moving parts. It just uses air and the shape of the pipes to do the job."

The goal is to predict the flow rate, or how much water moves, by knowing the pressure of the air being blown.

"This is significant because in nuclear fuel reprocessing, plants use conventional pumps – which have many parts on the inside that, after a long time of being in direct contact with radioactive sludges, start to become weak and eventually fail," Lopez said. "Which leads to the facility having to pause and stop the work to make repairs."

That's where JPPs come in, he said. "They have no internal components or moving parts. It's all one piece, which means if it does get damaged, it can easily be swapped out for a new one."

As part of Carasik's FAST research group, Lopez has taken advantage of many networking opportunities, including speaking with and discussing research with representatives from national labs like Los Alamos National Laboratory and Oak Ridge National Laboratory. He also had the opportunity to present his research at the American Nuclear Society student conference in New Mexico, where Lopez gave a presentation and network with many students who are actively in the same field.

*Brock Lodato working in the lab of Joshua Cohen, M.D.*

## VITAMIN D EFFECTS ON LARYNGEAL CANCER

Brock Lodato was 14 years old when he was diagnosed with Type 1 diabetes. It was a startling, life-altering diagnosis that has left him wondering why.

"I never received a reason why I developed diabetes, other than, 'it just happens sometimes,'" says Lodato, a biomedical engineering student at the Virginia Commonwealth University (VCU) College of Engineering. "I became fascinated with research because I wanted to find the 'why' behind my disease."

Lodato was eager to get involved with research and lab work as soon as he came to VCU. As a sophomore, he reached out to **Joshua Cohen, M.D.**, biomedical engineering research assistant professor, to see what opportunities might be available. He chose to study biomedical engineering because Lodato wanted to solve biological and medical problems, ultimately improving health care for individuals with challenges such as his own.

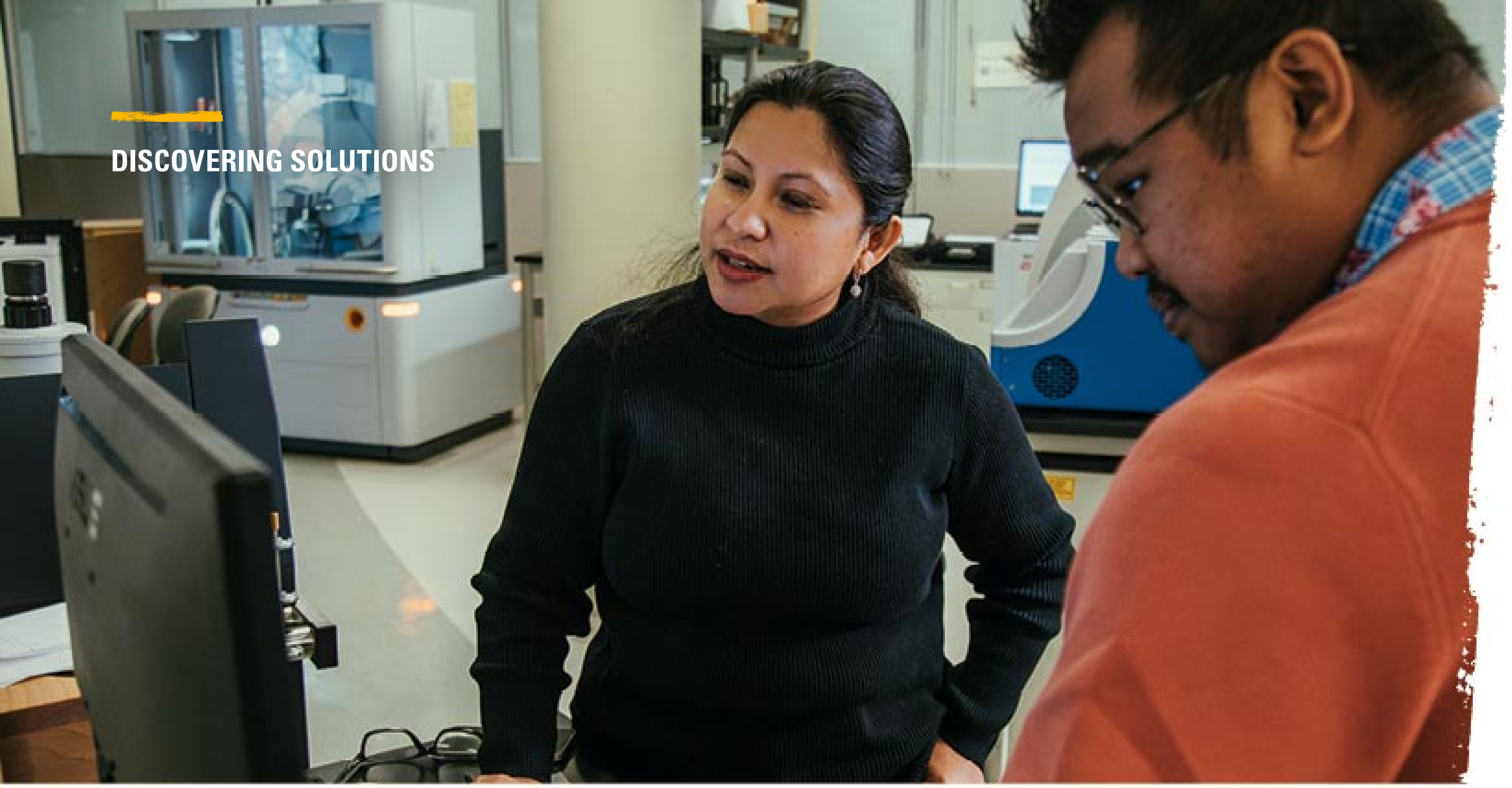
For three years, Lodato familiarized himself with the different areas of biomedical engineering through hands-on research and mentorship. His biggest research project as an undergraduate investigated the means by which a vitamin D metabolite affected the tumorigenic behavior in laryngeal cancer.

"Vitamin D treatment makes certain cell lines in laryngeal cancer tumors more aggressive," says Lodato. "This study successfully determined that it is due to different receptors on the membranes of different cell types within the tumor that determine its response to the vitamin D."

This type of research involvement is among what Lodato has valued most since coming to VCU. He also holds his classroom learning in high regard, citing Physics 2 and Biomechanics as favorites. As a result of these courses, Lodato's research interests have shifted from cells and tissues to a focus on forces and mechanics.

"I have hopes to design powered prosthetics and their mechanisms of interfacing with the human body so that users can reap the benefits of a prosthetic device without needing to worry about controlling it manually," says Lodato.

And should the opportunity arise to contribute to diabetes research, "I would love to do a study about it in the future," says Lodato.



*Radhika Barua, Ph.D., works with graduate student Anthony Duong at the Nanomaterials Core Characterization Facility.*

# ADDITIVE MANUFACTURING FOR A SUSTAINABLE FUTURE

**Radhika Barua, Ph.D.**, mechanical and nuclear engineering assistant professor, is paving the way to a sustainable future. Her research will transform magnet manufacturing, replacing the costly, energy-intensive processes for producing traditional rare-earth magnets. Through additive manufacturing — commonly known as 3D printing — Barua will create high-performance magnets for consumer and industrial electronics applications. With research focused on reducing production costs, minimizing energy consumption and limiting environmental impact, the application of her work also extends to renewable energy technologies like wind turbines and electric vehicles.

Using concentrated heat from a laser to melt metal, Barua's research employs a form of additive manufacturing called direct energy deposition (DED). Material "printed" by DED can be shaped into complex geometries in a molten state, perfect for creating precise, customized components.

Nanocomposite magnets consist of nanoscale grains, each measuring only a few billionths of a meter in size and exhibiting distinct magnetic properties. The interfaces between these grains, known as grain boundaries, play a pivotal role in determining the magnet's overall strength and efficiency. Properly aligned grain boundaries facilitate the smooth flow of magnetic forces and minimize energy losses. In contrast, poorly arranged boundaries obstruct magnetic alignment, significantly diminishing the magnet's performance.

Barua's research using DED carefully controls the formation of grains and how their boundaries interact. By printing nanocomposite magnets layer by layer, her team seeks to optimize the microstructure and ensure magnetic domains are aligned for maximum performance.

Molten material cools quickly once it is printed in DED. Rapidly solidified alloys demonstrate unique structural properties that lead to a fine microstructure, resulting in smaller grain sizes and a more uniform distribution of phases. In this instance, a phase is the name given to chemically uniform and physically distinct regions of material like the different elements an alloy is composed of.

Achieving the optimal size, shape and distribution of secondary phase particles is crucial for enhancing magnetic properties. To this end, Barua collaborates with **Jayasimha Atulasimha, Ph.D.**, Engineering Foundation Professor in the Department of Mechanical and Nuclear Engineering, to conduct micromagnetic simulations. These simulations model and predict the effects of different particle characteristics on the overall magnet behavior, facilitating the design of advanced nanocomposite magnets with improved performance.



# NATION'S FIRST PH.D. IN PHARMACEUTICAL ENGINEERING

Nadia Tasnim Ahmed has a tendency to seek out new experiences. It's what drove her to become the first student at Virginia Commonwealth University – and the country – to earn a Ph.D. in pharmaceutical engineering.

Ahmed was pursuing a career as a pharmacist in Bangladesh, her home country, when she became more interested in advancing the field of pharmacy through research. She went on to receive her master's degree in pharmaceutical chemistry at the University of Dhaka in Bangladesh.

In 2020, Ahmed was about to start working toward a Ph.D. in pharmaceutical sciences at VCU's School of Pharmacy when she came across an opportunity unlike any other. At that time, VCU had just launched the nation's first Ph.D. program in pharmaceutical engineering. The doctoral program is a collaboration between VCU's School of Pharmacy and College of Engineering to train students in areas of drug product development such as continuous manufacturing and drug-containing nanomaterials.

For her research, Ahmed used an analytical tool called mass spectrometry to study protein interactions at the molecular scale to better understand their role in disease. She specifically focused on an enzyme called neutrophil elastase, which influences the function of immune cells called macrophages.

By affecting how these macrophages respond to stress and injury, neutrophil elastase is believed to contribute to the lung inflammation and tissue damage associated with chronic obstructive pulmonary disease. Understanding the molecular mechanisms that drive this inflammation and tissue degradation can help researchers identify biomarkers and develop therapeutics for COPD.


# FIGHTING DISINFORMATION WITH REAL-TIME FRAUD DETECTION

Technology in elections is a hot-button issue. With the explosion of artificial intelligence, **Milos Manic, Ph.D.**, director of Virginia Commonwealth University's Cybersecurity Center, is concerned about the impact of AI on undecided voters.

To address shortcomings, Manic suggests looking at four areas: policy, safe and secure AI, user awareness and looking across borders to form alliances. His work in real-time AI fraud detection intersects strongly with election integrity and political disinformation.

Manic has completed more than 40 research grants in the area of data mining and machine learning applied to cybersecurity, infrastructure protection, energy security and resilient intelligent control. His research is aided by the Commonwealth Center for Advanced Computing, which VCU leads. Its IBM z16 supercomputer based on on-chip AI technology is specifically designed for real-time AI for fraud detection.

Combating misinformation as it happens influences its impact. The evolution of AI could bring machines smart enough to tailor their humanlike responses to specific users. Manic emphasizes focus on human psyches and human vulnerabilities, with a need for psychology experts, engineers and computer science professionals working together to develop real-time detection that can identify deep fakes in nanoseconds.

**Read the full Q&A with Milos Manic, Ph.D.**

DISCOVERING SOLUTIONS

# A SUMMER OF DISCOVERY:

## STUDENTS EXPLORE RESEARCH CAREERS THROUGH REU SITES

Every successful engineer starts as an inexperienced undergraduate. Their journey begins with an idea and, propelled by curiosity, those embers of interest can become a lifelong passion for exploration. Research Experiences for Undergraduates (REU) provide opportunity for inquisitive minds looking to build an early foundation of technical experience and applied knowledge. They also give undergraduates who are undecided about their educational path a first look at a career in research.

### BUILD BACK BETTER SUMMER REU FOR STUDENT SUCCESS

Learning the theoretical concepts behind pharmaceutical drug manufacturing, students engaged in experimental work related to the design and development of processes to synthesize, monitor and verify small molecule, protein and nanoparticle bioactive compounds. These items are important throughout the process of medication manufacturing and provide real-world experiences in problem solving, communication and teamwork within and between faculty laboratories.

"I learned a lot from my graduate student mentor, Kaitlin Kay, as well as other students and faculty from the Department of Chemical and Life Science Engineering," said Hurley Burgess. "Of particular interest to me was work around process analytical technologies (PATs) and their applications. I was introduced to PATs in the lab and they relate directly to my own research on UV-Vis spectroscopy, which measures the absorption of light in the UV and visible spectrums."

### REU SITE IN PHARMACEUTICAL ENGINEERING

The pharmaceutical industry is in need of talented engineers to solve the health challenges of the future. Developing this multidisciplinary workforce is the main objective of VCU's REU Site in Pharmaceutical Engineering. Students learn laboratory research techniques in tandem with co-curricular activities to enhance their career potential. This NSF-funded REU recruits students with limited opportunities for STEM research or who are from underrepresented communities within STEM.

Students receive additional benefits from the experience of faculty who are part of The Center for Pharmaceutical Engineering and Sciences at VCU. The center hosts the United States' only Ph.D. in pharmaceutical engineering.

### END-USER PROGRAMMING FOR CYBER-PHYSICAL SYSTEMS

For students without computer programming experience, the REU for End-User Programming for Cyber-Physical Systems (CPS) tasked undergraduates with software development. Robotics and home automation appliances are examples of CPS and encompass a range of technology that respond to and control items in our physical environment.

"I decided on the summer REU at the VCU College of Engineering because the interesting research addressed real world problems," said REU student Bobby Zita. "My project focused on developing a machine learning model to promote inclusivity in open-source software projects, an issue I find super important. I learned how research isn't necessarily a direct process. A few times over the course of my research, we had to change our approach or adapt based on our findings. I also learned a lot of technical skills that will help me succeed in graduate school."

### MECHANOBIOLOGY AT VCU

Engineering and life science intersect within the mechanobiology discipline. This REU provides opportunities for undergraduates to enhance their scientific literacy and communication, preparing them for graduate study or careers in research. Students participate in research projects to learn skills in the areas of microfluidics, mechanotransduction pathway analysis, functional tissue engineering, cell-material interactions and cancer cell biophysics.

*At the VCU College of Engineering, over 50 students participated in 2024 summer REU programs.*

### REU SITE IN MAGNETICS

This unique program is the only magnetics REU in the United States. Students learn the application of magnetics principles in a variety of practical and cutting-edge research scenarios. From employing voltage control of skyrmions that can be used to build synapses for neural networks to development of transcranial magnetic stimulation coils for brain therapy, a variety of detailed topics are presented for participants to examine.

"Being able to ask questions is an important part of the lab experience for me," said REU student Samantha Smith. "Talking to and forming relationships with people you may not directly work with really enriches the learning experience. It can be intimidating for someone who's just starting out, but it's part of the process. Working in a lab to gain valuable experience and interacting with individuals outside of my chemical engineering major made me happy."

### COMMONWEALTH CYBER INITIATIVE, CENTRAL VIRGINIA NODE

Students had the choice of three REU programs, hosted in part at VCU, and funded by the Commonwealth Cyber Initiative Central Virginia Node (CCI CVN).

The Soil Moisture Sensing with Wireless Signals participant, Micah Kinney, leveraged the propagation characteristics of wireless signals under the soil, which change based on the amount of water, to develop a low-cost moisture sensor using the channel state information of WiFi signals and machine learning models.

"Finding out what I truly love about research is one of the best things about this experience," said Kinney. "Having the time to solve problems and think of new methods for my experiments is great!"

Magnetic devices used in deep brain stimulation, also used at the REU Site in Magnetics, that are connected to a computer network are subject to the same threat of cyber attack as any other connected device. The Intentional Electromagnetic Interference in Brain Stimulation Devices REU tasked students to research techniques to protect this medical technology.

"It's fascinating to see the potential intersections of biomagnetics and computer science/computer engineering," said REU student Akshita Ramesh. "I have really enjoyed my REU experience. It has given me a huge opportunity to delve into topics I never thought I'd be able to do work with, especially as a computer engineer."

Optimizing large-scale computations is difficult with current technology because of the complexity involved. Students of the CCI CVN REU, titled An Exploration of Classical and Quantum Approaches to Solving Optimization Problems, explored the application of Quantum Annealing on D-Wave computers and the Quantum Approximate Optimization Algorithm on an IBM Quantum simulator to solve optimization problems that could have future applications for security and autonomous systems.

"The opportunity to collaborate with a diverse team of individuals from various backgrounds, disciplines and majors is what excited me most about this opportunity," said REU student Kennedy Martin. "Having not done research before, the experience was incredibly eye-opening. I was happy with my team and our ability to work with and rely on one another. It's been invaluable to leverage each other's strengths throughout the REU. This experience enhanced my research skills and gave me deeper insight into the research field as a whole."

**Read the full story online.**

## 02
# BUILDING TOGETHER

Our increasingly complex world requires expertise from many disciplines to move us forward. Collaboration is an essential part of engineering, with support for interdisciplinary research and education.


*Zeyun Wu, Ph.D. (front row, left) with members of his Computational Applied Reactor Physics Laboratory (CARPL).*

# COMPUTATIONAL PHYSICS FOR NUCLEAR REACTOR RESEARCH

**Zeyun Wu, Ph.D.**, associate professor in the mechanical and nuclear engineering department at VCU Engineering, is reshaping the future of nuclear power. With a background in computational reactor physics, Wu's research focuses on understanding reactor behavior through two aspects: multi-physics and multi-scale modeling.

The multi-physics approach integrates various physical phenomena, such as nuclear physics reactions, fluid dynamics, heat transfer and structural mechanics, into a unified simulation framework. The multi-scale modeling technique addresses the vast range of physical scales involved, from subatomic neutron interactions to meter-sized reactor components.

Wu's research can simulate the complex phenomena within reactors at different scales. These models, developed using advanced numerical methods, help predict reactor behavior under various conditions.

One of the models Wu uses tracks neutron behavior, a fundamental aspect to understand nuclear reactions. By understanding neutron distribution across space, time and energy domains, Wu's team can predict power distribution throughout the reactor core. This helps identify potential areas of heightened thermal activity that could pose safety challenges.

Beyond neutron behavior, Wu's research also explores how cooling fluids interact with neutrons and carry away thermal energy, a field known as thermal hydraulics, because how the reactor components are cooled significantly affects the neutron behavior as well. This also explains why the multi-physics modeling becomes essential for nuclear reactor simulations.

Wu founded the Computational Applied Reactor Physics Laboratory (CARPL) to continue his research in nuclear reactor modeling and simulation. Looking forward, Wu hopes his research will have a real-world impact on the upcoming shift in nuclear power in America.

Over the next 20 to 30 years, the nation's approximately 90 light-water-cooled nuclear reactors reach the end of their operational lifetimes. To replace them, experts are looking toward advanced, non-light-water-cooled reactors, such as the Molten Uranium Breeder Reactor (MUBR). Computational methods and tools like Wu's research lab developed will be essential to their development and implementation.


BUILDING TOGETHER

**I WANTED TO GO BEYOND THEORETICAL KNOWLEDGE... AND ENGAGE IN REAL-WORLD PROBLEM-SOLVING.**

MOHAMED ELRAHHAL

# FUELING CAREER GROWTH AT NEWPORT NEWS SHIPBUILDING

A partnership between the VCU College of Engineering and HII's Newport News Shipbuilding (NNS) is reshaping the educational landscape and powering the future of engineering excellence. The Technical Graduate Program (TGP) allows engineers to earn their Master of Science in Mechanical and Nuclear Engineering (MNE). Courses are delivered synchronously, allowing the students to take master's level classes remotely, but in real-time with VCU Engineering professors. Many of the classes are held conveniently after work or in the evenings.

The largest industrial employer in Virginia, NNS has leveraged its corporate partnership with VCU to upskill its engineering workforce across disciplines and facilitate career advancement. A steady pipeline of skilled professionals is needed to tackle the complexities of naval engineering, particularly in nuclear-powered vessels. The company builds nuclear-powered aircraft carriers and submarines for the U.S. Navy.

Comprehensive coursework in reactor design, thermal-hydraulics, structural mechanics and computational modeling is part of the program, ensuring students develop both theoretical knowledge and practical skills.

Mohamed Elrahhal, a system engineer at NNS, entered the master's program to deepen his expertise in mechanical and nuclear engineering and to advance his career in a specialized direction.

"I wanted to go beyond theoretical knowledge and engage in practical applications, research and real-world problem-solving," said Elrahhal, who completed his degree in May 2024.

With a passion for learning and research, Elrahhal found one of the most enjoyable and valuable aspects of the master's program was the depth of technical knowledge combined with real-world applications in nuclear engineering.

As a Systems Engineer, Elrahhal's role at Newport News Shipbuilding involves defining the requirements, designing, developing, building and maintaining tools, processes and data architecture within a Model-Based Enterprise.

With a background in civil engineering, Elrahhal has already been able to apply his new technical skills for analyzing and optimizing reactor cooling systems using principles from heat transfer and thermal-fluid sciences, and by applying mechanics of materials and structural analysis to ensure nuclear facility components meet safety and longevity standards.

"The knowledge gained from VCU's mechanical nuclear engineering courses has had practical applications in my work environment, from engineering design and safety assessments to collaborating with teams on regulatory compliance and system optimization," Elrahhal said.

As Virginia's engineering landscape continues to evolve, the VCU-Newport News Shipbuilding partnership stands as a model for effective industry-academic collaboration. With plans to expand program offerings and potentially include emerging technologies such as advanced manufacturing and digital engineering, both institutions are positioned to meet future workforce needs.

**Read the full story online.**

# NEW LEADERSHIP. NEW OPPORTUNITIES.

**New leadership at the College of Engineering positions the Departments of Computer Science and Mechanical and Nuclear Engineering to continue educating the next generation of engineers while conducting impactful research that benefits our world.**

### KEMAL AKKAYA, PH.D.

**Kemal Akkaya, Ph.D.**, a distinguished professor and cybersecurity expert, is the new chair of the Department of Computer Science at the Virginia Commonwealth University (VCU) College of Engineering. Akkaya comes to VCU from Florida International University (FIU), where he was an Eminent Chaired Scholar Professor in the Knight Foundation School of Computer and Information Sciences.

At FIU, Akkaya directed the Advanced Wireless and Security (ADWISE) Lab, conducting research in cybersecurity, privacy, trustworthy AI, Internet of Things (IoT), cyber-physical systems, and blockchain technologies. His work has garnered over $20 million in research funding at FIU and resulted in approximately 300 peer-reviewed publications. He also holds 10 patents.

"Leading the Department of Computer Science at VCU is a great honor for me," said Akkaya. "I look forward to strengthening the College of Engineering's already established programs, supporting faculty and students, and finding the research niches we excel in to continue capitalizing on what makes the VCU Engineering experience unique."

A leader in academic innovation, Akkaya spearheaded the creation of the first IoT Bachelor of Science degree program in the United States. He also developed new IoT curricula and courses. For the past decade, Akkaya has directed numerous NSF-funded research programs in cybersecurity and privacy, mentoring a large number of graduate and undergraduate cybersecurity students.

### ARVIND AGARWAL, PH.D.

**Arvind Agarwal, Ph.D.**, is the new chair of the Department of Mechanical and Nuclear Engineering. A renowned academic and pioneering researcher in advanced materials and manufacturing, Agarwal comes to VCU from Florida International University (FIU), where he held the position of Distinguished University Professor in the Department of Mechanical and Materials Engineering (MME).

During Agarwal's seven-year tenure as MME chair at FIU, he spearheaded numerous initiatives resulting in significant departmental growth. This includes an increase in the undergraduate graduation rate. Research awards also grew from $1.8 million in 2017 to $24 million in 2024 and Ph.D. enrollment doubled during his tenure as chair.

"My goal as chair of the Mechanical and Nuclear Engineering department at VCU is to support faculty in their educational and research endeavors," said Agarwal. "I also want to extend that support to students at all levels of the academic journey, whether at the undergraduate or graduate level."

Focused on additive manufacturing of metals and ceramics, Agarwal's research includes the development of cold spray, plasma spray, wire arc additive manufacturing and ultrahigh temperature ceramics. His work also explores boron nitride nanotube and graphene-reinforced composites and coatings, as well as the nanoindentation and mechanical properties of biological materials.



# ADVANCED COMPUTING RESOURCES FOR VCU RESEARCHERS

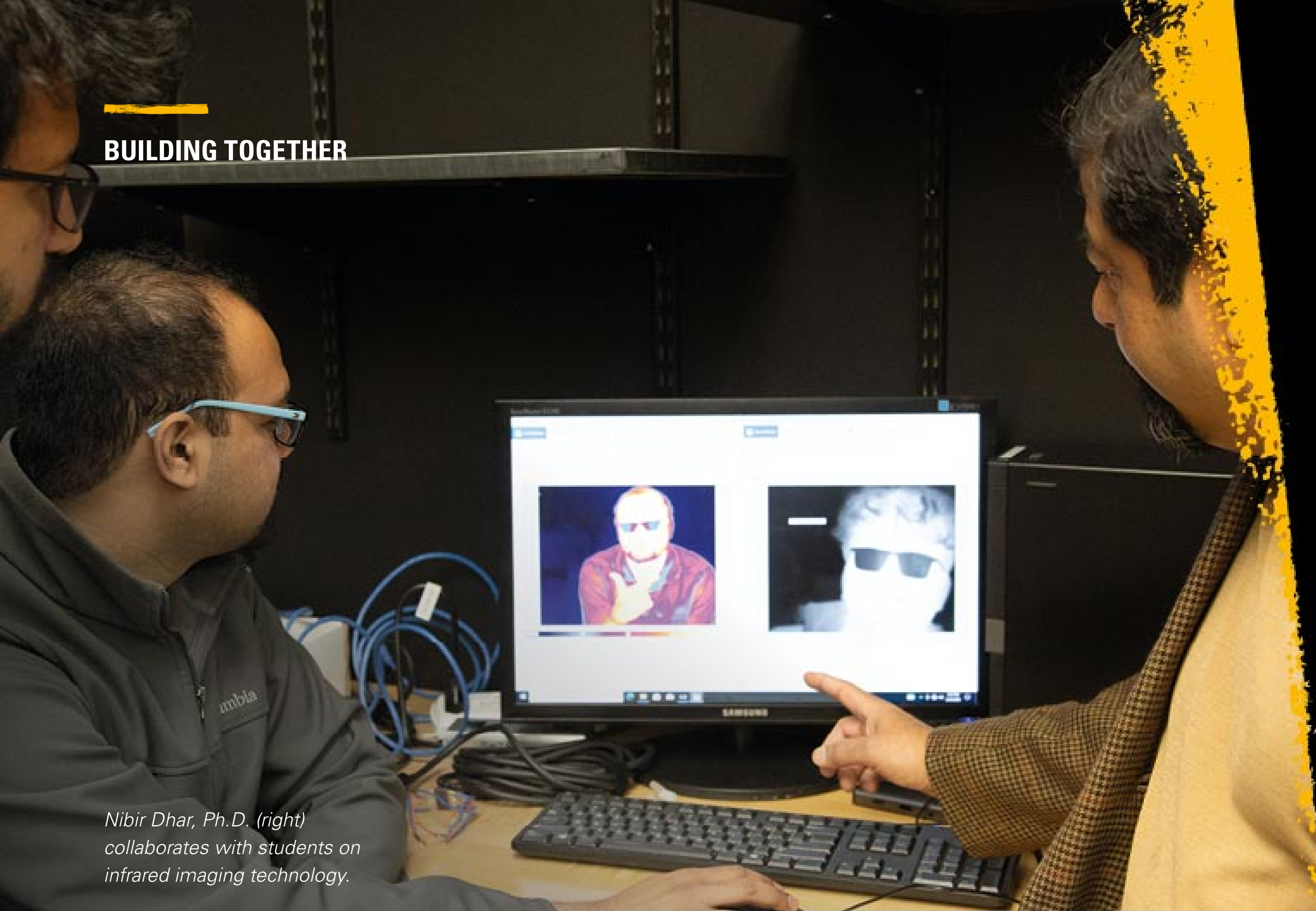
The High Performance Research Computing (HPRC) core facility provides the VCU community with computing resources for research, teaching and outreach activities. Led by Computer Science Professor **Preetam Ghosh, Ph.D.**, and Technical Director Mike Davis, the primary mission of the HPRC is to advance scientific research at VCU in areas that benefit from large-scale computation.

Ghosh's research focuses on complex networks and systems biology, leveraging advanced techniques in modeling and simulation, applied artificial intelligence and network science to address societies' grand challenges in the biomedical sciences.

Supercomputing clusters, large-scale storage systems, specialized software and technical expertise in research computing are all available through HPRC. Its resources will support research computing in mathematics and computational sciences, physical and chemical sciences, engineering, life sciences, medicine, and arts and humanities.

Athena and Apollo are the HPRC's main clusters, which provide services like parallel computing, GPU computing, large-scale storage, compilers, DNA/RNA/proteomics pipelines, computational fluids dynamics, quantum chemistry and AI.

Mechanical and Nuclear Engineering Associate Professor **Ibrahim Guven, Ph.D.**, uses the HPRC for simulating the effect of the elements, such as rain, ice and debris, on aircraft traveling at high speeds. Part of this work involves digitally reproducing the raindrop-shock layer interaction, which gives the droplet shape at the time of contact with the aircraft surface. Accurate modeling of the pressure being applied at this point is crucial to the result. With the HPRC's computing power, Guven can apply methods to test aircraft surface designs for damage mitigation, like seeing if different material or a layered coating system leads to less deterioration. Funded by the Department of Defense, Guven collaborates with the University of Minnesota, Stevens Institute of Technology and the University of Maryland to help build more resilient civilian and military aircraft.



*Nibir Dhar, Ph.D. (right) collaborates with students on infrared imaging technology.*


**THE UNDERGRADUATE CLI SCHOLARS PROGRAM, PROVIDES HANDS-ON EXPERIENCE IN ADVANCED TECHNOLOGIES.**

# CONVERGENCE LAB INITIATIVE DRIVES INNOVATION WITH ADVANCED TECHNOLOGIES

With an additional grant from the Department of Defense (DoD), VCU's Convergence Lab Initiative (CLI) continues advancing research in the areas of quantum and photonic devices, microelectronics, artificial intelligence, neuromorphic computing, arts and biomedical science.

Partnership is at the heart of CLI and what makes the initiative unique. CivilianCyber, Sivananthan Laboratories and the University of Connecticut are among several collaborators focusing on cutting-edge, multidisciplinary research and workforce development. The lightweight, low-power components CLI helps develop are capable of transforming military operations and also have commercial applications. The Convergence Lab Initiative has 25 collaborative projects in this area focused on:

**Electro-optic and Infrared Technologies:** Enhancing thermal imaging for medical diagnostics, search-and-rescue operations and environmental monitoring. This improves military intelligence, surveillance and reconnaissance capabilities.

**Radio Frequency and Beyond 5G Communication:** Developing ultra-fast, low-latency communication systems for autonomous vehicles, smart cities and telemedicine. Accelerating advancements in this area also address electronic warfare challenges and security vulnerabilities.

**Optical Communication in the Infrared Wavelength:** Increasing data transmission rates to create more efficient networks that support cloud computing, data centers, AI research and covert military communications.

**Edge Technologies:** Creating low size, weight and low power-consuming (SWaP) computing solutions for deployment in constrained environments, such as wearables, medical devices, internet of things devices and autonomous systems. These technologies enhance real-time decision-making capabilities for agriculture, healthcare, industrial automation and defense.

College of Engineering students at VCU have an opportunity to engage with cutting-edge research as part of the DoD grant. Specialized workforce development programs, like the Undergraduate CLI Scholars Program, provide hands-on experience in advanced technologies. The STEM training also includes students from a diverse range of educational backgrounds to encourage a cross-disciplinary environment.

Students can also receive industry-specific training through CLI's Skill-Bridge Program, which facilitates direct connections between business needs and academic education. Unlike the DoD program for transitioning military personnel, the CLI Skill-Bridge is open to students from VCU and other local universities, creating direct connections between industry needs and academic training.

**Read the full story online.**


*Students work on "Icarus,"a discus-style and glider made almost entirely from 3D-printed components.*

# GLIDING INTO FIRST PLACE WITH ADDITIVE MANUFACTURING

The VCU College of Engineering's student chapter of the American Society of Mechanical Engineers (ASME) claimed top honors at the ASME EFx Innovative Additive Manufacturing 3D (IAM3D) Competition. This year's challenge required students to design and manufacture a discus launch glider using additive manufacturing technology.

Their entry, affectionately named "Icarus," was designed to be launched discus-style and was made almost entirely from 3D-printed components, with the exception of the air wrap around the wings, electronics and fasteners. Despite challenging weather conditions that affected all competing teams' flight opportunities, ASME at VCU's innovative approach to additive manufacturing secured them first place in the competition.

"Our chapter continues to push the boundaries of what we can accomplish with additive manufacturing in competition vehicles," said Nathalia Melgarejo-Salvatierra, ASME at VCU's President. "The IAM3D Competition gives us an opportunity to apply innovative solutions to engineering challenges while connecting with teams from across the country."

The team showcased exceptional innovation by successfully utilizing Lightweight PLA (also known as "Air PLA") - a difficult material to print with that no other competing team managed to implement successfully. Additionally, the students engineered Icarus with a modular design that could be disassembled for air travel and reassembled at the competition site, demonstrating practical engineering solutions.

"Participating in competitions like these provides students with invaluable hands-on experience and the opportunity to apply concepts learned in the classroom to real engineering challenges," **Charles Cartin, Ph.D.**, ASME at VCU faculty advisor and mechanical and nuclear engineering professor, said. "The team's first-place finish demonstrates their exceptional technical abilities and innovative thinking."

ASME at VCU has been designing and manufacturing vehicles to compete in ASME EFx events since 2020, with this year's performance representing their strongest showing to date.

*Rodrigo Spínola, Ph.D. (center), Daniel Falcão, D.O. (left) and Kostadin Damevski, Ph.D. (right) are working to address a critical shortage of AI professionals in healthcare.*

# EXPERIENTIAL LEARNING TO BUILD HEALTHCARE AI WORKFORCE

**Rodrigo Spínola, Ph.D.**, computer science associate professor, is developing "living labs" for undergraduates at the Virginia Commonwealth University College of Engineering. Living labs (LL) are a form of experiential learning that integrates multidisciplinary science, technology, engineering and math (STEM) education with hands-on educational opportunities. The project is co-led by professors **Kostadin Damevski, Ph.D.**, associate professor of computer science, and Daniel Falcão, D.O., associate professor of neurology and interim chief of the Division of Vascular Neurology. It's supported through funding by the National Science Foundation (NSF).

"We're looking to address a critical shortage of AI professionals in the healthcare industry," says Spínola. "Our goal is to create a successful model for experiential learning that other colleges can emulate in order to continue strengthening the workforce in this area. The opportunities we provide students will bridge the gap between theoretical knowledge and practical application."

At the AIHealth-LL, students will gain practical experience in developing, deploying and servicing AI systems for health. It will also recruit students from diverse backgrounds to provide STEM education for historically underrepresented and underserved communities.

Traditional undergraduate STEM programs focus on developing technical abilities, neglecting soft skills, like collaborative problem solving, that engineers and computer scientists need to deliver increasingly complex products. Real-world scenarios incorporated into the AIHealth-LL allow students to apply their technical expertise and theoretical knowledge before graduation, making them more valuable to future employers and ensuring the economic competitiveness of the AI workforce in the United States.

Initial plans for AIHealth-LL focus on developing the relationship between engineering and neurology. Undergraduate computer science students will work with researchers in the VCU Department of Neurology and VCU Health.

03

# SERVING HUMANITY

An engineer's ultimate goal is to improve life for individuals and society. This is engineering for humanity. Whether it is a student embarking on a new career path or established faculty with wide-ranging research impact, our destination is the same — leaving the world better than we found it.

## INFLUENTIAL MENTORSHIP INSPIRES ACADEMIC CAREER

Racheida Lewis, Ph.D., a 2013 Virginia Commonwealth University electrical engineering graduate, credits her alma mater with providing the foundation for her career as an assistant professor at the University of Georgia.

Several faculty members played pivotal roles in Lewis' development. She credits Electrical Engineering Professors **Rosalyn Hobson-Hargraves, Ph.D.**, **Afroditi V. Filippas, Ph.D.**, and **Michael Cabral, Ph.D.**,for their mentorship and support in becoming the successful engineer she is today.

Hobson-Hargraves was the first faculty member Lewis met on campus through her participation in the Summer Transition Program as part of the Virginia–North Carolina Louis Stokes Alliance for Minority Participation. "Having Black teachers was common for me," Lewis said. "But I didn't realize what a unique experience it was to form a connection with a Black female in electrical and computer engineering. She remained invested in my success since I began my studies."

Lewis was also encouraged by Filippas, who was her Introduction to Electrical and Computer Engineering instructor. "I remember at the end of the first day of class, she stopped me and some of the other women and said: 'If you ever need anything, and I mean anything, please feel free to come to me. We need more women in engineering.' I have admired her ever since and made it part of my mission to make her proud," Lewis said.

During the last semesters of her engineering degree, Lewis struggled with some advanced coursework. "Dr. Cabral saw potential in me I didn't see in myself," Lewis said. "When I didn't understand something, he took the time to explain and help me learn important engineering concepts. My experience with Dr. Cabral's kindness made me realize I wanted to become a faculty member. And it was his letter of recommendation that got me into grad school at UVA."

Today, Lewis teaches electrical and computer engineering at the University of Georgia and conducts research on improving access to engineering education.

*Members of the Software for Social Good VIP team. From left to right: William Benton, Ph.D., VCU da Vinci Center assistant professor, Inho Park, Quynh Nguyen and Ami Zhang.*

## REDUCING TRAFFIC IN URBAN AREAS? THERE'S AN APP FOR THAT.

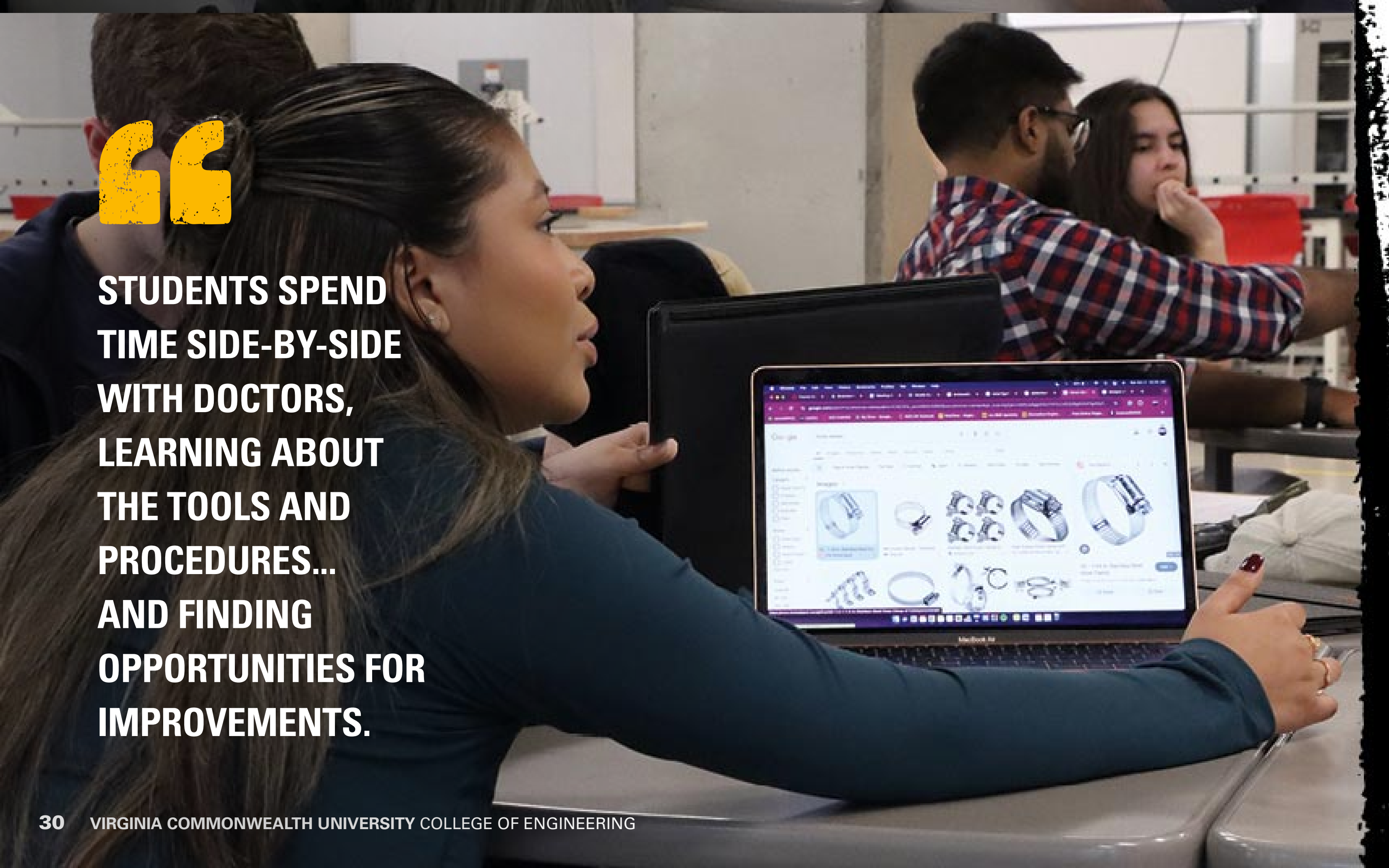
Students Ami Zhang, Inho Park and Quynh Nguyen were recognized by the 2024 New York Product Design Awards for designing "CoPath," a mobile travel app created with the purpose of reducing traffic and carbon emissions in urban areas with high population density. This team is a part of Software for Social Good (SSG), which is a multidisciplinary Vertically Integrated Project (VIP) that provides an experiential learning opportunity where computer science, VCU Arts, the VCU da Vinci Center and an array of other majors can intersect.

CoPath aims to change the concept of Demand-Responsive Transport (DRT), ride-pooled buses functioning similarly to taxis with fares that are approximately the same rate public transit charges. Choosing the most efficient route for driving passengers to their destination, CoPath's algorithm uses the fewest number of vehicles possible within a reasonable time frame. What makes it different from other ride-sharing apps is that it doubles as a social platform, meaning users can find routes of riders traveling the same direction. This way, they can group together ride pools within the app.

CoPath's key advantages are its ability to transport mass amounts of riders quickly in a matter that's environmentally friendly and being a low-cost solution for parts of the city considered "low-demand." In particular, students in the local area can pool together so that they all arrive on campus when they need to be there. This makes for less new requests and a shorter wait time. Cities also benefit due to CoPath being an inexpensive version of DRT that gives patrons control over their trip's punctuality and settings.

SERVING HUMANITY

# ENGINEERING SOLUTIONS TO GLOBAL HEALTH PROBLEMS



> STUDENTS SPEND TIME SIDE-BY-SIDE WITH DOCTORS, LEARNING ABOUT THE TOOLS AND PROCEDURES... AND FINDING OPPORTUNITIES FOR IMPROVEMENTS.

Hours or days away from the nearest medical facility, people living in remote or underserved communities have limited access to healthcare. A team of engineers, doctors, researchers and students at Virginia Commonwealth University are tackling this problem through the Acute Medical Care and Systems Strengthening (ACCESS) Vertically Integrated Project (VIP). With a focus on global health, the team seeks creative solutions for health delivery, including improving access to surgical procedures and advanced diagnostic screenings.

Co-led by Edgar Rodas, M.D., associate professor of surgery at the VCU School of Medicine, the team is co-advised by **Rebecca Heise, Ph.D.**, Inez A. Caudill, Jr. Distinguished Professor and chair of the Department of Biomedical Engineering, **Thea Pepperl, Ph.D.**, biomedical engineering assistant professor, and Aamer Syed, M.D., associate professor of internal medicine at the VCU School of Medicine.

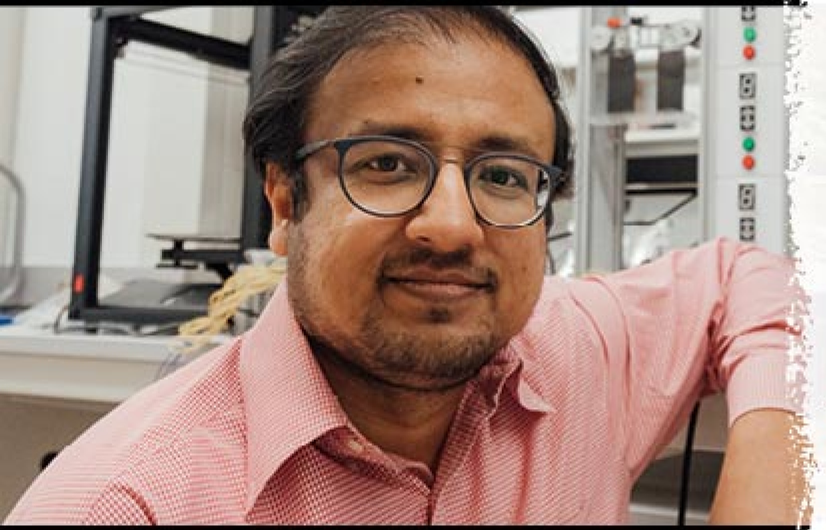
At the start of the fall semester, College of Engineering students attend the VCU School of Medicine's ACCESS symposium to meet with global health leaders who provide insight to the challenges doctors face in low-resource medical environments. The College of Engineering then hosts a brainstorming session, where ideas become tangible through the use of Computer Aided Design (CAD) software to create digital models of products that address project needs. These designs eventually become physical prototypes. Design prototypes are then tested with the help of the Center for Human Simulation and Patient Safety located at VCU Health's Medical College of Virginia (MCV) Campus.

Once engineering students begin with ACCESS VIP, they spend time side-by-side with doctors, learning about the tools and procedures professionals use and finding opportunities for improvements. This includes working in procedure rooms, intensive care units and clinics alongside students and clinical advisors from the VCU School of Medicine. This ensures ACCESS VIP engineers have a clinical frame of reference and can understand the real-world, day-to-day needs of doctors and clinical researchers.

Current ACCESS VIP projects include redesigning a laparoscopic surgery tower to make it more compact, facilitating its use in a mobile surgical truck that can access remote locations, and a dual purpose bronchoscope than can go from flexible, for diagnostics capable of exploring a patient's airway, to rigid, used for patient interventions like stopping heavy bleeding.

Remote locations, low-resource areas, economic constraints and other challenges impose strong limits for ACCESS VIP engineers. Restrictions of funding and materials often result in solutions that are environmentally sustainable as well as financially feasible.

**Read the full story online.**



## SECURING CRITICAL INFRASTRUCTURE

**Irfan Ahmed, Ph.D.**, associate professor and a leading researcher in digital forensics at the College of Engineering Department of Computer Science, has been honored with the Community Service Award by the NSA/DHS Center for Academic Excellence in Cybersecurity (CAE) community. A joint venture between the National Security Agency (NSA) and the Department of Homeland Security (DHS), the CAE community recognizes institutions and individuals that contribute to the nation's cyber workforce.

Among the first ten contributors to the NSA's National Cybersecurity Curriculum Program (NCCP) in 2018, Ahmed played a pivotal role by developing modules for crucial areas in cybersecurity: digital forensics, network penetration testing and industrial control system security. These modules have become the most widely used resources by academic institutions across the United States, reflecting the significant impact of his work.

Ahmed has also been elevated to Fellow of the American Academy of Forensic Sciences (AAFS). This distinction recognizes Ahmed's significant and sustained contributions to the field of digital forensics, particularly in the area of industrial control systems.

With research focused on developing advanced capabilities to investigate digital evidence within industrial control systems, Ahmed is making advancements critical to the security of our nation's infrastructure. His work has direct implications for national security and the protection of critical sites such as nuclear power plants and power grids.

## IMPROVING MEDICATION ACCESS WITH CUTTING-EDGE TOOLS

Bao Chau received a B.S. in chemical engineering from VCU in 2022, and he is now a student in the university's pharmaceutical engineering Ph.D. program, a collaboration of the College of Engineering and the School of Pharmacy. His research focuses on relieving the drug development burden and increasing the availability of medication with the use of novel machine learning techniques.

Chau was selected as an NSF Graduate Research Fellow last year. He became interested in this topic as a result of personal family health challenges that placed his family in financially difficult situations. With the strain modern medicine puts on people financially, physically and mentally, Chau seeks to improve the quality of life for as many people as possible.

The main challenge in Chau's research has been to overcome failure while still being confident in his ideas, concepts and theories. The first specific challenge he encountered was understanding and applying machine learning in the field of chemistry. Before beginning his Ph.D., Chau had limited experience with coding and no experience with machine learning. However, with time and effort, he was able to grasp the concepts and apply them directly to chemistry, resulting in the development of a novel method for optimizing chemical processes.

**Scan for the full Q&A.**

## TESTING AN ADVANCED DRONE SAFETY SYSTEM WITH NASA

From agriculture and law enforcement to entertainment and disaster response, industries are increasingly turning to drones for help, but the growing volume of these aircraft will require trusted safety management systems to maintain safe operations.

NASA is testing a new software system to create an improved warning system – one that can predict hazards to drones before they occur. The In-Time Aviation Safety Management System (IASMS) will monitor, assess, and mitigate airborne risks in real time. But making sure that it can do all that requires extensive experimentation to see how its elements work together, including simulations and drone flight tests.

NASA conducted studies with Virginia Commonwealth University (VCU) students and several other universities at locations throughout the United States. Each drone testing series involved a different mission for the drone to perform and different hazards for the system to avoid. Scenarios included, for example, how the drone would fly during a wildfire or how it would deliver a package in a city.

All of this work is led by NASA's System-Wide Safety project under the Airspace Operations and Safety program in support of the agency's Advanced Air Mobility mission.

## FIRST ROBOTICS DAY IN VIRGINIA

The inaugural Virginia For Inspiration and Recognition of Science and Technology (FIRST) Robotics Day was hosted March 31 by the VCU College of Engineering, highlighting VCU's 26-year commitment to advancing STEM education through robotics.

"The VCU College of Engineering is extremely proud of our long partnership with FIRST and FIRST Robotics," said **Gary Tepper, Ph.D.**, senior associate dean for academic affairs. "We are just as excited today as we were back in 1999, the first time we hosted a competition in the Siegel Center. We look forward to the continuing partnership between us and FIRST."

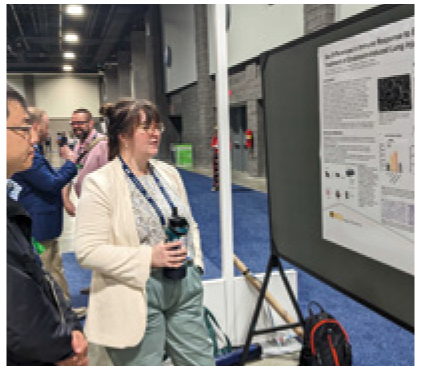
During his welcome remarks, Tepper highlighted VCU Engineering's commitment to experiential learning through several new initiatives, starting with a minor in robotics and autonomous systems engineering — the first of its kind in Virginia.

"The courses you take will be project-based, much like the hand-on work students are doing now in FIRST competitions," he explained. "We really think that's the best way to get students passionate about learning and engineering."

The robotics industry is projected to grow at a compound annual rate of nearly 20% over the next few years, becoming a $27 billion industry worldwide, according to the Virginia General Assembly resolution.

## RESEARCH SYMPOSIUM HIGHLIGHT: CASIE SLAYBAUGH

Research Weeks 2025 at VCU celebrates its commitment to the work of its scholars. At the graduate student symposium, Casie Slaybaugh showcased her research into reducing cases of acute respiratory distress syndrome, a condition that can cause blood oxygen to dip to dangerous levels. She has found that inhaling synthetic surfactant — the same molecule that reduces surface tension in dish soap — could help people in acute respiratory distress replenish their natural surfactant levels and breathe better.



"If you've ever done the trick where you put food coloring on milk, then touch it with a drop of dish soap, that's kind of what surfactant does in our lungs," said Slaybaugh, a biomedical engineering Ph.D. candidate in the College of Engineering. "In acute respiratory distress syndrome, surfactant levels decrease and the surfactant that is produced can be built incorrectly, leading to higher surface tension and causing further injury to the lung. By giving an inhaled powder form of surfactant, we can fix that problem."

SERVING HUMANITY

# CAPSTONE DESIGN EXPO

From quiet apps to noisy rocket engines, the ingenuity of Virginia Commonwealth University College of Engineering students was on vibrant display at the 2025 Capstone Design Expo. The annual event showcased more than 90 student projects and presentations, the result of more than eight months of work among students, project partners and faculty advisers. The prototypes and inventions focused on solutions that could have a lasting impact on society and humankind. Below are some awards from this year's expo.

## PEOPLE'S CHOICE AWARD: SUPPORT FOR A GOLFER WITH AN AMPUTATED FINGER

*Kyia Hill, Elna Manoj, Valentina Santos Agreda and Rachel Scardina, with instructor Henry Donahue, Ph.D.*

In this biomedical engineering project, the team worked with QL Plus, a nonprofit veterans organization, to create a prosthetic finger and special glove with foam padding for the golfer. The veteran has an amputated index finger and a minimally functional middle finger on her left hand, and she struggles with grip stability and experiences painful vibrations while golfing.

The glove prototypes feature synthetic leather material with an opening to allow for direct contact of the prosthetic with the residual limb. Padding was used to reduce painful vibrations. The team also modified the golf club, and it used oscillation testing and an accelerometer to measure shaft frequencies and vibration.

**Scan for the full list of award winners**

## DIRECTOR'S CHOICE AWARD: NAVAL DEFENSE TECHNOLOGY TO DISABLE ELECTRONICS

*AJ Critz, Craig Lyle, Joseph Lee and Chris Treblic, with instructor Da-ren Chen, Ph.D.*

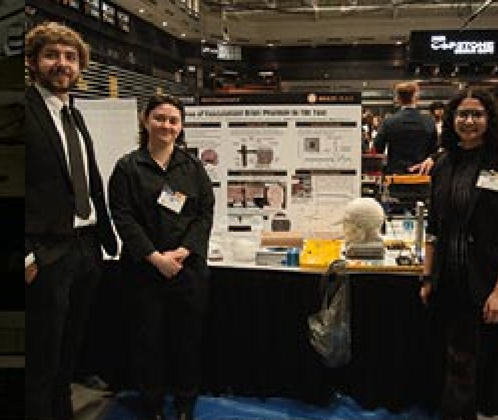
The Naval Surface Warfare Center's Dahlgren Division sponsored this mechanical and nuclear engineering project. A top facility for weapon research and development, the Dahlgren lab develops technology such as high-power microwave devices that disable electronics nonlethally. To test such instruments, surrogate outboard motors require accurate artificial loads. But the limitations of current dynamometers — devices that measure a motor's torque and rotational speed to calculate instantaneous power — in capacity, durability and usability cause delays.

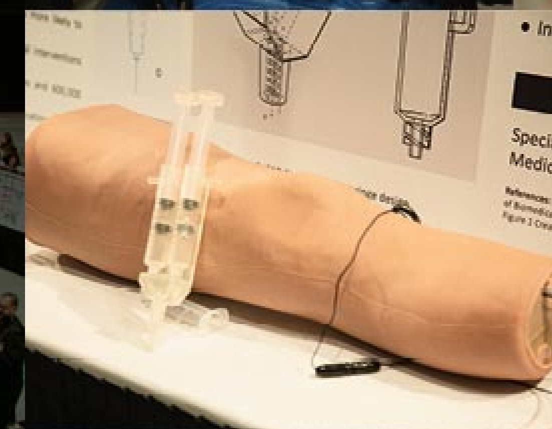
This team designed a dynamometer capable of handling more horsepower while operating in high radio-frequency environments and allowing fast swaps of outboard motors. In creating a better artificial load, the project can streamline testing with simulations that needn't be conducted at sea.

## EXCELLENCE IN DESIGN: DEVICE TO IMPROVE SPEED AND SAFETY OF PRODUCING POTATO CHIPS

*Josiah Dieffenbach, Ian Gildea, Jaden Casey and Cedric Wilson, with instructor Gennady Miloshevsky, Ph.D.*

Eldon's Famous Snacks is attempting to boost production of its artisanal potato chips, but it faces a bottleneck in the process. At the sizing phase, oversize potatoes risk clogging the conveyors and slicers – and the potatoes might produce uneven or oversized chips, which could break during packaging and transport. The mechanical and nuclear engineering project team designed a pneumatic potato-halving device that automatically cuts oversized potatoes into manageable halves, improving the speed and safety of the current process.

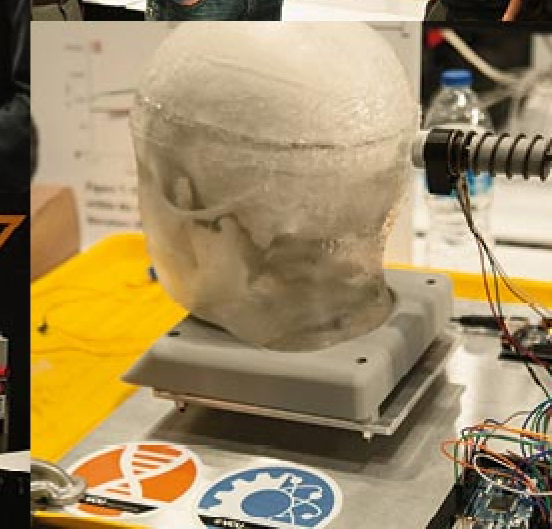








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