VCU

College of Engineering

ENGINEERING FOR VIRGINIA'S WORKFORCE

2017–18 ANNUAL REVIEW // VOLUME 11

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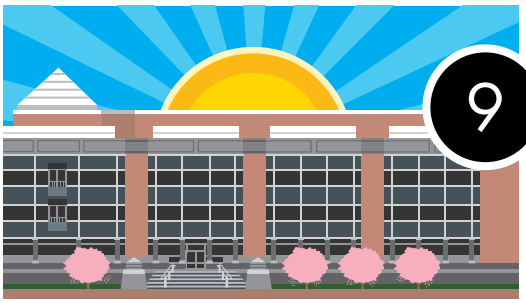

MISSION

Through teaching and research, the VCU College of Engineering creates knowledge and transforms ideas in engineering and the life sciences into technologies that enhance regional and global prosperity. We prepare our students for leadership and entrepreneurship through collaborative and interdisciplinary partnerships.

VISION

To establish the VCU College of Engineering as a preeminent program in education, research and technological development at the intersection of engineering, business, medicine and the life sciences.

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FROM THE DEAN

> **MAKING A DIFFERENCE FOR HUMANKIND** IS AT THE HEART OF OUR RESEARCH PROGRAMS.

It's been a year of transformation at VCU Engineering. Major gifts have scaled up our impact. Our campus is growing. Even our name is different. We're now the VCU College of Engineering, a designation that reflects the scope of what we offer and who we are.

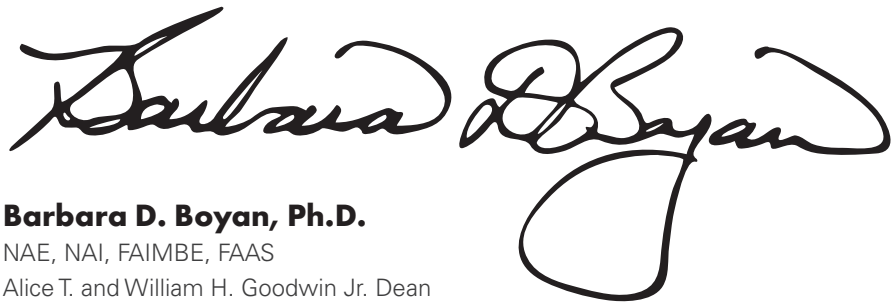
Making a difference for humankind is at the heart of our research programs. The worldwide reach of our pharmaceutical engineering initiative grew with a $25 million grant from the Bill & Melinda Gates Foundation to establish the Medicines for All Institute. In the institute's labs, researchers design models to reduce the production cost of essential health treatments and increase global access to lifesaving medications.

An unexpected gift from a longtime friend has forever changed our ability to give students a first-class engineering education that equips them to contribute to the workforce. The C. Kenneth Wright Engineering Access Scholarship helps qualified students earn an engineering degree without dependence on loans. The remarkable first cohort of Wright scholars graduated in May. They're already paying it forward with their own donations to the program. I hope you will follow their example.

A highly visible change is at the corner of Cary and Belvidere streets, where we broke ground in June for the Engineering Research Building. We'll soon watch a state-of-the-art engineering facility emerge. In addition to advanced labs, it will have a 9,000 square-foot Innovation Maker Facility for collaborative, hands-on prototyping. It will optimize our partnerships with Virginia companies as we continue to nurture our industry-responsive maker culture at VCU Engineering — where our motto is "Make it real."

No question about it. It's been a very good year. But as you'll see in this report, we're focused on the future. We can't get there alone. Help us keep making it real.

GO RAMS!



Barbara D. Boyan, Ph.D.
NAE, NAI, FAIMBE, FAAS
Alice T. and William H. Goodwin Jr. Dean
VCU College of Engineering

ASSOCIATE DEANS

"Problem solving, design and innovation are essential outcomes to becoming a successful engineer. Our programs are rapidly expanding opportunities for students to engage in experiential learning activities, projects and facilities."

L. Franklin Bost, M.B.A., IDSA, FAIMBE
Executive Associate Dean for Innovation & Outreach

Bost's background includes academic instruction in product design and development, FDA regulatory processes, financial and strategic planning along with extensive industry experience in product commercialization, marketing and sales, corporate and tactical planning, international business development and P&L responsibilities in the medical device, industrial and consumer product markets. He is extensively involved in enhancing collaborations between medical professionals and engineering development experts for translational development and commercialization of new technologies and products for improving adult and pediatric patient care.

"In challenging times, universities must be bastions of inclusion and free expression. Through training in entrepreneurship and interdisciplinary collaboration, our graduates find creative solutions to this century's challenges."

Afroditi V. Filippas, Ph.D.
Associate Dean for Undergraduate Studies

Filippas is responsible for all aspects of the undergraduate program. She has been in her current role since fall 2010, significantly growing enrollment and retention with her energy and enthusiasm for molding holistic engineers who are independent, lifelong learners. Previously, she served as the associate chair of the Department of Electrical and Computer Engineering. Filippas strives to help all students achieve their goals through her own teaching, and through working with Student Services and the college's undergraduate program directors to develop effective advising programs and educational experiences.

"I want to help faculty and students refine research questions, get funding to test their ideas and then see their research results used to improve human lives."

Ram B. Gupta, Ph.D.
Associate Dean for Faculty Research Development

Gupta guides our student and faculty researchers to be innovative, concise, compelling and driven. Prior to joining VCU in 2014, he served as a program director at the National Science Foundation and a professor at Auburn University. He has authored about 400 research papers, presentations, books and patents and obtained 50 major grants in chemicals, pharmaceuticals and fuels. Gupta's leadership and faculty mentoring skills have increased research grants threefold in the last three years at VCU.

"VCU is poised to make significant leaps forward in recognition. If the next three years are anything like the last three, it's going to be dramatic. I want to contribute to this success."

John D. Leonard II, Ph.D.
Executive Associate Dean for Finance & Administration

Leonard oversees business and administrative operations, applying his administrative and data analytics expertise to finance, strategic planning and performance measurement. He came to VCU in 2016 from the Georgia Institute of Technology, where he was associate dean for finance and administration in the College of Engineering. He is widely published and is a recognized expert in the analysis and design of Intelligent Transportation Systems and coordinated traffic signal systems, as well as innovative, data-driven approaches to higher education administration.

"I'm excited to craft an environment where people feel secure and welcome. From labs to equipment and other technologies, I make sure people have what they need to succeed."

Zvi Schwartz, D.M.D., Ph.D., FAIMBE
Associate Dean for Strategic Operations

Schwartz brings 35-plus years of biomedical engineering, dental medicine and research expertise to VCU. He joined the college in April of 2013. His duties include evaluating building space for future expansion to support a growing student body and new research initiatives, while also maintaining all existing office space, classrooms and laboratories. With more than 450 journal publications and numerous awards under his belt, including the American Academy of Periodontology's R. Earl Regeneration Award, Schwartz makes sure our engineering facilities fit the college's strategic and research goals.

"I want to make the value of a VCU graduate degree loud and clear. Recruiting, retaining and graduating talented students from every part of the country and world shows VCU's momentum."

Gregory E. Triplett, Ph.D.
Associate Dean for Graduate Studies and Research

Triplett is a first-generation graduate who found his voice and ability to make a difference through academic teaching and research. Prior to joining VCU in January of 2016, he spent 11 years at the University of Missouri (Mizzou). There, he received the William T. Kemper Fellowship for Teaching Excellence Award, the Booker T. Washington Advisor of the Year Award and the Air Force Office of Scientific Research's Young Investigator Award. Triplett secured nearly $9 million in total grant funding at Mizzou and more than doubled student participation in honors research.

DEPARTMENT CHAIRS

"We are active players in a global information-based, highly interconnected society. Our students are ready for the forefront of the information revolution with solutions for big data and cybersecurity in domains including bioinformatics and health sciences."

Krzysztof Cios, Ph.D., D.Sc., M.B.A., FAIMBE
Computer Science

Computers can write articles from data. They can rapidly crunch big data to create personalized consumer experiences. Even health care procedures and diagnostics are conducted by computers. Since coming to VCU in 2007, Cios has built up a robust department, equipped with the research skills needed to continue propelling technological progress. He has also developed specialization programs that allow students to focus on data science and cybersecurity and a dual-Ph.D. program with the University of Córdoba in Spain.

"I want our program to be the program of choice for students considering undergraduate and graduate biomedical engineering in the commonwealth. We also want to be the employer of choice for new faculty."

Henry J. Donahue, Ph.D., FAIMBE
Biomedical Engineering

Donahue came to VCU in 2016 after a distinguished 21-year career at Pennsylvania State University. Under Donahue's leadership, VCU's Department of Biomedical Engineering has seen a 300 percent increase in research expenditures and has increased its faculty by 77 percent. In fall 2018, the department welcomes its largest incoming first-year class in the college's history. Donahue will continue fostering transdisciplinary collaborations with VCU's schools of Medicine, Dentistry and Pharmacy, including an initiative in rehabilitation and regenerative medicine and a symposium on the mechanobiology of disease.

> **VCU ENGINEERS HAVE BEEN FLOODING THE VIRGINIA WORKFORCE.** IN RICHMOND'S HVAC INDUSTRY ALONE, WHEN I STOP BY A CONTRACTOR OR A CONSULTANT'S OFFICE, IT SEEMS LIKE THEY'VE JUST HIRED MORE VCU ENGINEERING GRADUATES. THIS SPEAKS TO THE QUALITY OF STUDENTS THE COLLEGE PUTS OUT.
>
> **Andy Hobson**
> TLC Inc.

"Nearly 80 percent of our undergraduates are participating in research initiatives. We have some very special, extremely self-motivated individuals who teach me new things each day."

B. Frank Gupton, Ph.D., FAIMBE
Chemical & Life Science Engineering

As a student, Gupton's perspective changed forever when he was asked to participate in research with a professor. Suddenly, he saw how what he learned in class related to real-world needs. Now he strives to give VCU faculty and students the tools to be successful and productive. He joined VCU in 2007, and became department chair in 2008. Gupton shares his experience from 30-plus years in the chemical and pharmaceutical industry to motivate students and to increase departmental efficiencies.

"From developing renewable energy technologies to designing new products, our students and faculty make a difference. There's never been a more exciting time to study mechanical or nuclear engineering."

Gary C. Tepper, Ph.D.
Mechanical & Nuclear Engineering

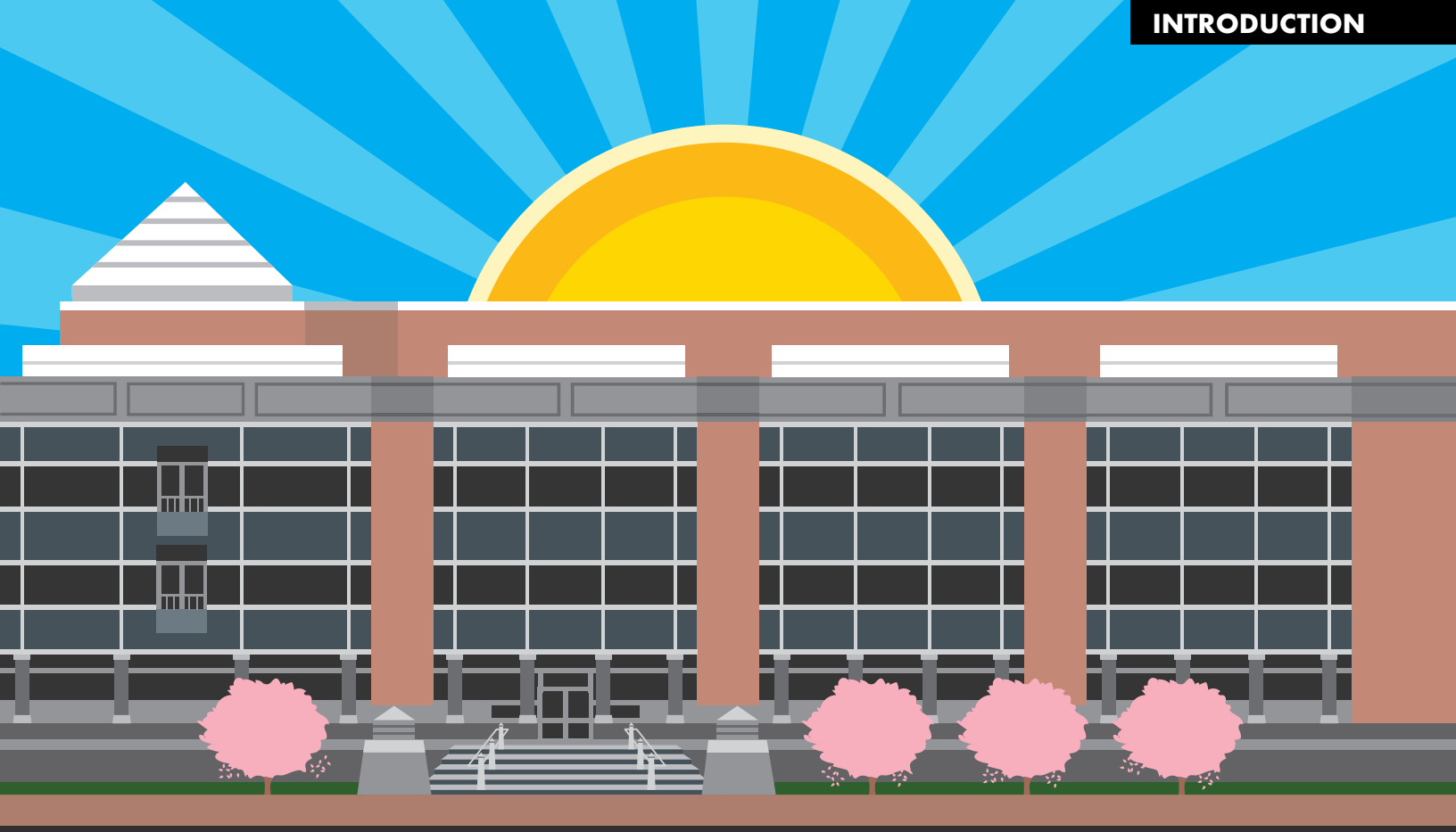
Tepper earned his Ph.D. from the University of California at San Diego and joined VCU in 1997. He accepted the department's chair position in 2009 and has overseen a rapid expansion of the department including the addition of nuclear engineering programs, the nation's first hybrid Ph.D. program in mechanical and nuclear engineering, new global education opportunities, new laboratories to foster student creativity and innovation and the addition of outstanding world-renowned faculty. He's excited to continue the momentum and help faculty and students achieve their full potential.

"ECE has always been at the forefront of new technologies and will continue to lead the way in Internet of Things (IoT), smart cities and smart health."

Erdem Topsakal, Ph.D.
Electrical & Computer Engineering

Topsakal joined VCU in June of 2015 and quickly assembled an undergraduate student advisory board tasked with shaping the direction of department initiatives and helping rally the student body to apply what they're learning in classrooms out in the community. These students take part in open houses, high school visits and other exciting projects. Topsakal also formed a general advisory board of industry leaders, high school principals and faculty from other institutions to evaluate department programs, its research portfolio and curriculum.

BETWEEN FY15 AND FY17, VCU ENGINEERING RESEARCH FUNDING INCREASED BY **67%**



THE ROAD TO COLLEGE

Virginia Commonwealth University's School of Engineering is now the VCU College of Engineering. This change reflects the college's increases in programs, research, faculty and student census and supports its mission to advance a collaborative, creative and entrepreneurial engineering culture.

College leaders said the growing scope of VCU's academic programs in engineering — and its robust sponsored research program with collaborations across the Monroe Park and VCU Health campuses, and the VA Bio+Tech Park — are in keeping with its designation as a college.

"Since 2013, our faculty numbers have doubled, and our extramural research funding has quadrupled," said Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering. "Becoming the VCU College of Engineering recognizes the rapid growth during the last five years and positions us to continue our forward trajectory."

VCU defines a college as a large academic unit with a broad scope of degree-granting programs covering multiple disciplines. The university's 22-year-old engineering college now offers six undergraduate degrees. It also has six master's programs, as well as a Master of Product Innovation degree affiliated with VCU's da Vinci Center. The college offers five doctoral programs in engineering.

The college houses four interdisciplinary centers and institutes: the VCU Institute for Engineering and Medicine, the Nanomaterials Core Characterization Facility, the C. Kenneth and Dianne Harris Wright Virginia Microelectronics Center and the Medicines for All Institute.

The advancement in status from school to college also underscores VCU's broadening platforms to connect engineering research, student engagement and degree programs with economic development and community partnerships. Recent examples of these intersections include a $25 million grant from the Bill & Melinda Gates Foundation to establish the Medicines for All Institute and a major gift from Altria to foster the college's development of maker culture. A new 133,000-square-foot Engineering Research Building broke ground in summer of 2018 and will open in 2020. The facility will support advanced research, student innovation and economic development initiatives.

John D. Leonard II, Ph.D., executive associate dean for finance and administration, said the change sets the stage for continued increases in engineering enrollment, faculty and facilities.

"The title change to college recognizes the breadth and scope of our activities and more clearly communicates the expansive role that we play in the region and the commonwealth," he said.

DIVERSITY

#1

VIRGINIA ENGINEERING SCHOOL FOR PERCENTAGE OF HISPANIC GRADUATES

INCREASE IN HISPANIC/ LATINO UNDERGRADUATE STUDENTS SINCE 2012

INCREASE IN UNDER-REPRESENTED MINORITY STUDENTS SINCE 2012

A state-of-the-art research building slated to open at VCU Engineering in 2020 will significantly expand the college's laboratory capacity and serve as a collaboration hub to support advanced research, economic development initiatives and hands-on approaches to engineering. The facility's design emphasizes makerspaces, collaborative research facilities and flexible gathering areas. Richmond-based architecture firms Baskervill and Smith McClane Architects and Boston-based firm Goody Clancy are designing the 133,000 square-foot building, which is being financed with investments from the state, VCU and private donations. The Engineering Research Building (ERB) will be situated on the southeast corner of Cary and Belvidere Streets, in close proximity to Engineering East Hall and the VCU School of Business.

AN EXPANDING CAMPUS FOR A GROWING PROGRAM

VCU Engineering's steady growth over its 22 years in numbers of undergraduate and graduate students, academic programs, research funding and full-time faculty underpins the need for additional facilities to support continued expansion. Current engineering facilities on the Monroe Park campus include East and West Halls, the C. Kenneth and

WE'RE **EXPANDING**

Dianne Harris Wright Virginia Microelectronics Center and the VCU Institute for Engineering and Medicine building. In the VA Bio+Tech Park, the college's research labs and associated facilities occupy 10,000 square feet in Bio+Tech One and 60,000 square feet in Bio+Tech Eight.

Growth is accelerating as the college executes its strategic plan. The new building will support expanding research funding, new faculty recruitment and continued increases in student enrollment targets. The ERB also supports the college's strategic roadmap, which emphasizes student-centered learning, meaningful research, workforce development and a culture that promotes creativity, entrepreneurship and global perspectives.

"The college was established as a public-private partnership with a mandate to educate engineers who will fuel economic development in the region," said Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering. "The ERB reflects our commitment to meeting this goal. Virginia's support of this critical addition to our teaching and research mission is a strong vote of confidence in our program. We are proud to step into this next phase of our development with the commonwealth as our partner."

THE BLUEPRINT: ENGINEERING'S FOUNDATIONS — AND FUTURE

The building's entrance at Cary and Belvidere will be a prominent focal point. Extending East and West Hall's tradition of architectural details that refer to past eras of engineering advancement, the ERB's pavilion design alludes to the 19th-century dawn of industrial engineering with a roofline that features updated smokestacks. A brick-and-glass pavilion and large courtyard will have power-equipped seating areas to allow students to research and collaborate outside as well as in the large internal atrium.

Plans for the building include a first floor that is entirely devoted to workforce development in engineering. Facilities include the Office of Engineering Career Services and economic

development resources for the college's active internship and co-op programs. A 9,000-square-foot Innovation Maker Facility (IMF) will nurture and support maker culture among engineering students and with affiliated programs. "Economic development in a university setting is about preparing students to contribute to society when they enter the workforce. The ERB's research labs, Innovation Maker Facility and collaboration spaces provide an important new cornerstone in supporting the commonwealth's objectives for economic growth in our region," said L. Franklin Bost, M.B.A., IDSA, FAIMBE, the college's executive associate dean for innovation and outreach and director of the VCU Institute for Engineering and Medicine.

Floors two, three and four will have extensive faculty research labs, offices, spaces for graduate and undergraduate students doing cutting-edge research and interactive areas for group seminars. Multidisciplinary and collaborative faculty research "neighborhoods" will be furnished with wet laboratory facilities for biomedical research and dry laboratory spaces. These areas — like the rest of the ERB — are being designed to house tomorrow's equipment and methodologies. This mandates "a building design flexible enough to accommodate advances in engineering, which come quickly," said Paul Rocheleau, M.B.A., the college's executive director of strategic programs.

Rocheleau said that for this reason, the blueprint also has open zones to permit updates over time. He added that the new building's impressive spaces will house something even more crucial to creativity and technological discovery. "Buildings are a wonderful enabler," he said. "But it's people who drive the innovation."

MAKER CULTURE MAKES IT REAL

The spacious ground-floor IMF anchors the ERB in hands-on approaches to engineering, design and development. Altria, a major supporter and employer of graduates from the VCU College of Engineering, School of Business and other disciplines, recently donated $1 million to VCU Engineering to enhance student creativity and maker culture.

The maker movement, which emphasizes creation of new devices within communal makerspaces, has risen in prominence in academia, industry and the wider community. The idea is rooted in creativity and engineering fundamentals, according to Bost, an experienced product developer and biotechnology entrepreneur. "Maker culture grew out of mechanical and industrial design movements, which launched the Industrial Revolution," he said. "Every company I have

worked for has had makerspaces to support the development of new products and product improvements. For engineering, this really promotes economic development."

The expansive facility will provide new tools and methodologies that advance the college's long standing culture of creative approaches to engineering, design and development. The IMF will support collaborative projects involving students from engineering, business and the da Vinci Center. "Make it real" capabilities in the IMF will include hand tools, tabletop equipment, industrial grade manual and CNC machines, laser cutters, bench electrical fabrication, 3D printing and other equipment. The IMF's offerings will supplement equipment currently available in the West Hall Innovation Shop, which will be relocated when the new facility opens in 2020.

Many engineering students arrive with advanced training in technology-based prototyping, but much less experience fabricating things by hand. The IMF aims to change that by letting users get their hands dirty as they delve into engineering challenges. "We want to empower all our interested students to participate in ideation and creation with multiple hands-on learning experiences," Bost said.

MORE MAKERSPACE

The VCU College of Engineering Foundation purchased the former Grubbs' Auto Service property in downtown Richmond. The 59-year-old building is slated to be refurbished and opened in late 2018 as a makerspace for student projects and student vehicle performance teams.

"The Engineering Foundation's generous support for this purchase allows the college to expand capacity and capabilities in providing experiential learning environments for students to enhance their skills in innovation, entrepreneurship and leadership that companies value in future hires," said L. Franklin Bost, M.B.A., IDSA, FAIMBE, executive associate dean for innovation and outreach, director of the VCU Institute for Engineering and Medicine.

VCU Engineering capstone courses regularly have nearly 100 student teams working on senior design projects. Many project challenges presented by industry supporters are benefiting from the heavy machine equipment available in the new facility. This space also supports continued development of the students' Formula SAE (Society of Automotive Engineers) competition vehicles, along with projects such as the Hyperloop at VCU pod *(see page 54)* and solar-powered vehicle teams.

ENGINEERING for VIRGINIA'S WORKFORCE

The VCU College of Engineering is building Virginia's highly skilled workforce. From industry-driven collaborations like Capstone Design to internships and co-ops that immerse students in the workplace — and keep them working in Virginia after graduation — VCU Engineering is partnering with companies to fill the skills gap.

"The problems engineers are called on to solve are in the real world. Public-private partnerships are our foundation and help us educate students to make it real," said Barbara D. Boyan, Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering. "As we've matured, we've reached out more and more to our industry partners to take advantage of their experience and to train engineers who add value to their work."

75%

OF VCU ENGINEERING STUDENTS STAY IN VIRGINIA AFTER GRADUATING.

PARTNERING WITH INDUSTRY

> **VCU ENGINEERING GRADUATES COME TO ALTRIA PREPARED TO CONTRIBUTE FROM DAY ONE.** VCU ENGINEERS HAVE GRIT. THEY'RE READY TO ROLL UP THEIR SLEEVES. THEY ALSO HAVE TIES TO THE STATE, SO THEY'RE PART OF THE COMMUNITY. THEY'RE INTERESTED IN BEING HERE —AND STAYING HERE.
>
> **Mark Cruise**
> Altria

The college's industry partnerships are visible all over campus, and beyond. On any given day, employers like Altria, CoStar or Dominion Energy are giving tech talks, hosting networking sessions and advising on student projects. VCU Engineering also provides advanced training — on location — to those already in the field.

The state's economic growth depends on availability of skilled talent, and VCU Engineering takes advantage of its ideal position to supply it, said L. Franklin Bost, M.B.A., IDSA, FAIMBE, director of VCU's Institute for Engineering and Medicine and executive associate dean for innovation and outreach.

"VCU is the state's only engineering program located in the capital and a center of industry. This builds a solid, often long-lasting, connection between our graduates and Virginia's economy," Bost said.

Numbers tell the same story. Ninety percent of VCU Engineering students are from the commonwealth, and 75 percent stay in Virginia after graduation. Its high percentage of first-generation and transfer students helps keep skilled talent in Virginia, according to Boyan. "The ties our students have to the state, plus all the thriving companies and startups, create an ecosystem that lets us train engineers and watch them flourish in the state's workforce," she said.

The college and its partners want to keep it that way.

Companies asked for a skilled workforce in key areas. The college responded with undergraduate cybersecurity and data science certificates, partnerships with the Commonwealth Center for Advanced Manufacturing and courses in automation and controls.

The college is also helping mid-career engineers take the next step. VCU, with the state's only comprehensive nuclear engineering program, worked with Newport News Shipbuilding to offer its engineers a commute-free master's degree program that provides classes remotely, but in real-time.

Whether on campus or on location, dynamic collaborations like these are part of VCU Engineering's bedrock, according to Paul F. Rocheleau, M.B.A., executive director of strategic development.

"When you look at the historical perspective of the college, you see that we were created with every intention of being a partner to business," he said. "Over time, we have become the focal point for providing talent to Virginia's innovation economy."

> **WE LOVE HIRING RAMS.** THEY ANALYZE AND ASK, 'HOW CAN WE DO THIS DIFFERENTLY?' SOME OF OUR NEW PROCESSES HAVE COME FROM VCU ENGINEERING INTERNS. WE HAVE VCU INTERNS EVERY SUMMER AND HAVE A VERY HIGH RETENTION RATE. THEY'RE THE FUTURE OF OUR WORKFORCE, SO WE WANT TO GET THEIR BUY-IN EARLY.
>
> **Nicole Baab**
> Dominion Energy

> **WE'RE IMPRESSED WITH VCU ENGINEERING STUDENTS** FROM THE DIVERSITY THEY OFFER TO THEIR STRONG WORK ETHIC, WHICH PARTLY RESULTS FROM MANY OF THEM BEING FIRST-GENERATION COLLEGE STUDENTS, AND OF COURSE TO THEIR TECHNICAL CAPABILITIES.
>
> **Lawrence Cummings**
> Trane

EXPERIENTIAL LEARNING

> **VCU ENGINEERS ARE INTUITIVE, EXCELLENT PROBLEM SOLVERS AND HARD WORKERS.** FOR THE FIRST TIME, ENGINEERS FROM VCU OUTNUMBER THOSE FROM VIRGINIA TECH IN OUR RICHMOND OFFICE. VCU HAS CERTAINLY DEVELOPED A RICH ENGINEERING CULTURE FOCUSED ON THE REALITIES OF BUSINESS AND INDUSTRY NEEDS.
>
> **Temple Ballard**
> SUEZ Water Technologies and Solutions

When VCU's engineering graduates join the workforce, they've already met Virginia companies through programs like Capstone Design and the Vertically Integrated Projects (VIP) program.

Capstone Design is the culmination of the undergraduate curriculum. Businesses, the medical center, industry and nonprofits provide challenges for teams of seniors to invent solutions to real engineering problems. Student teams work two semesters on need analysis, problem definition, solution concepts, prototype development and evaluation. Their solutions are presented at the Capstone Design Expo in VCU's Siegel Center.

"Companies like Newport News Shipbuilding, Hamilton Beach Brands, Suez North America and ChemTreat are regular sponsors of Capstone projects, and they end up hiring a lot of our graduates," said Bennett C. Ward, Ph.D., director of project outreach and Capstone Design coordinator.

Students aren't just working with companies, they're forming new ones, too. Engineering capstone teams are now partnering with entrepreneurship students from the School of Business in a transdisciplinary collaboration that brings real-world, experiential learning to both programs. "Capstone Design continues to become increasingly entrepreneurial, with a real mandate to move ideas from Capstone to companies," Boyan said.

Research initiatives also turn out workforce-ready engineers. VCU is Virginia's only university in the prestigious VIP Consortium, which includes university participants from around the world. The VIP@VCU program engages early undergrads on multi-year research projects with more senior students, grad students and faculty. These long-term efforts bring students into complex projects and give them opportunities to take on leadership roles as they advance in their academic path toward graduation. A number of VIP projects also include business, medicine, arts and science students.

The Dean's Undergraduate Research Initiative (DURI) provides one-year fellowships for students to participate in advanced research alongside the college's grad students, postdocs and faculty.

"These programs give undergrads professional-level research experience," Boyan said. "They're not 'junior varsity.' They're part of an advanced lab team and come out ready for commercial and government labs."

The Dean's Early Research Initiative (DERI) introduces high school students to engineering with one-year research fellowships for sophomores, juniors and seniors. Many DERI fellows go on to major in engineering as a result.

BUILDING THE PIPELINE

Internships — and a new co-op program — show students how their engineering education applies to the real world. They also benefit employers.

"These programs provide important feedback that helps us align our curriculum to meet employer needs," said Anita Hazel Taylor, director of VCU Engineering Career Services. "They also give employers more data points for evaluating candidates than a 45-minute interview would."

VCU Engineering's internships and co-ops are also an important cost savings and force multiplier for businesses.

"Recruiting talent is risky and expensive," said Rocheleau. "These programs let employers get to know students well and help cut through the challenges of going out and recruiting an 'unknown quantity.' Students also provide businesses with energy, new ideas and fresh perspectives"

In the last five years alone, more than 600 engineering students have completed internships. Among the more than 300 employers that regularly hire VCU Engineering interns are big Virginia companies like Capital One, Northrop Grumman and WestRock as well as high-impact small and medium-sized businesses such as ColonialWebb and FCP Brakes.

Trailblazing Rams have organized their own co-ops since the college's early years, but VCU Engineering started a formal co-op program in 2017. Unlike internships, co-ops offer a full-time work opportunity for at least three semesters. Co-op students can alternate between working full time and taking classes. Participating in a co-op assignment allows students to help offset the expense of their education while providing them with career skills.

Once the college formalized the program, participation took off. More than a third of the 145 co-op work rotations since 2014 were completed in the 2017 academic year alone. Employer demand continues to build. Eleven co-op rotations are already scheduled for summer 2019.

VCU Engineering's industry-responsive programs and partnerships are rooted in the college's collaborative, creative and entrepreneurial culture. Boyan sees that culture as its key differentiator.

"We're nimble, forward thinking and not bogged down by tradition," she said. "We're meeting the world where it is and partnering at every intersection."

600+

ENGINEERING STUDENTS HAVE COMPLETED INTERNSHIPS SINCE 2013.

145+

ENGINEERING STUDENTS HAVE COMPLETED CO-OPS SINCE 2014.

300+

EMPLOYERS REGULARLY HIRE VCU ENGINEERING STUDENTS AS INTERNS.

"**ENGINEERING STUDENTS FROM VCU HAVE ADDED SO MUCH TALENT, DRIVE AND CREATIVITY** TO OUR TEAM BY BUILDING NEW PRODUCTS TO SUPPORT OUR WORLDWIDE CUSTOMER BASE. AMC IS LUCKY TO HAVE SUCH A TREMENDOUS TALENT POOL IN OUR BACKYARD. VIRGINIA IS LUCKY TO ADD THESE STUDENTS TO THE STATE'S WORKFORCE."

Anthony Uliano
AMC Technology

WRIGHT

ENGINEERING ACCESS SCHOLARSHIP PROGRAM

> **BECAUSE OF THE WRIGHT SCHOLARSHIP PROGRAM,** STUDENTS WILL BE ABLE TO GRADUATE FROM THE VCU COLLEGE OF ENGINEERING WITH A HIGHLY VALUED DEGREE AT A MODEST COST.
>
> *Barbara D. Boyan, Ph.D.*

A historic gift from longtime benefactor C. Kenneth Wright establishes the college's flagship scholarship program.

The inaugural 19 recipients of VCU's new Wright Engineering Access Scholarship represent many backgrounds and engineering disciplines, but they have one thing in common with their benefactor C. Kenneth Wright: a place in the college's history.

The Wright Engineering Access Scholarship was established in 2017 with Wright's historic $5 million gift, the largest scholarship gift in the college's history. He designed his gift to help qualified students, especially nontraditional students, earn an engineering degree without dependence on loans. As the college's flagship scholarship program, it annually provides merit- and need-based awards to a broad base of students, including community college transfers. The first recipients include first-generation college students, transfers to VCU, immigrants to the U.S. and a single custodial father of four.

"We want to make economic opportunities real," said Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering. "Because of the Wright scholarship program, students will be able to graduate from the VCU College of Engineering with a highly valued degree at a modest cost. This really matters, because nobody wants young people to take on debt."

Wright and his late wife Dianne were entrepreneurs in the vehicle rental and travel industries, owning several businesses that operated primarily in Virginia with affiliations across the nation. Wright's advice to the first cohort? "Be honest and work hard," he said. "America is a great country, and Richmond is a great city. You can make both even greater."

He also hopes others will contribute to the Wright Engineering Access Scholarship fund to expand college opportunities for more students pursuing careers in engineering.

MEET THE FIRST RECIPIENTS OF THE WRIGHT ENGINEERING ACCESS SCHOLARSHIP

PICTURED FROM LEFT:

Lionel Brookins
MAJOR: Electrical Engineering
HOMETOWN: Chesapeake, Virginia
CAREER GOAL: Engineering consulting firm ownership.
FUN FACT: Is an avid bicyclist and basketball player.

Daveon Barbee
MAJOR: Mechanical Engineering
HOMETOWN: Richmond, Virginia
CAREER GOAL: An engineering career that benefits the homeless.
FUN FACT: Is often called a "clean freak."

Michael Horton
MAJOR: Mechanical Engineering
HOMETOWN: Richmond, Virginia
CAREER GOAL: Working in a creative atmosphere on problems related to climate change.
FUN FACT: Is a graduate of the VCUarts sculpture and extended media program.

Jake Littlepage
MAJOR: Mechanical and Nuclear Engineering
HOMETOWN: Mechanicsville, Virginia
CAREER GOAL: Nuclear engineering with Dominion Energy.
FUN FACT: Studied in Germany and worked on a research reactor there.

Erwin Karincic
MAJOR: Computer Engineering
HOMETOWN: Sarajevo, Bosnia
CAREER GOAL: Network security architecture.
FUN FACT: Can build a computer in less than 10 minutes.

Jordan Karim
MAJOR: Mechanical and Nuclear Engineering
HOMETOWN: Richmond, Virginia
CAREER GOAL: Nuclear engineering.
FUN FACT: His game collection currently includes 60 board games — so far.

Cara Brooks
MAJOR: Biomedical Engineering
HOMETOWN: Hampton, Virginia
CAREER GOAL: Clinical engineering or project management.
FUN FACT: Loves to cook.

Jared Carey
MAJOR: Electrical Engineering
HOMETOWN: Ashburn, Virginia
CAREER GOAL: Innovation in the sonic field.
FUN FACT: Plays guitar in a rock band.

C. Kenneth Wright
Scholarship benefactor

Brandon Watts
MAJOR: Computer Science
HOMETOWN: Prince George, Virginia
CAREER GOAL: Working in machine translation for Google.
FUN FACT: Has met Bill Nye in person.

Hayat Adawi
MAJOR: Chemical and Life Science Engineering
HOMETOWN: Midlothian, Virginia
CAREER GOAL: Industry or graduate research in chemical engineering.
FUN FACT: Is obsessed with pretzels, roasted cashews and extra dark chocolate.

Virang Kumar
MAJOR: Biomedical Engineering
HOMETOWN: Glen Allen, Virginia
CAREER GOAL: Medicine.
FUN FACT: Has a black belt in karate.

DongChen "Jay" Guan
MAJOR: Computer Science
HOMETOWN: Fuzhou, China
CAREER GOAL: Software engineering.
FUN FACT: People never believe he is an introvert.

Jay Spangler
MAJOR: Biomedical Engineering
HOMETOWN: Lynchburg, Virginia
CAREER GOAL: General surgery practice.
FUN FACT: His hobby is fishing.

Matt Beckwith
MAJOR: Chemical Engineering
HOMETOWN: Arlington, Virginia
CAREER GOAL: Product development engineer.
FUN FACT: Grew up in Hawaii before moving to Virginia.

NOT PICTURED:

Bailee Crisinati
MAJOR: Chemical and Life Science Engineering
HOMETOWN: Somers, Connecticut
CAREER GOAL: Production engineering in industry.
FUN FACT: Earned her second-degree black belt at age 16.

Mengue France Raissa
MAJOR: Biomedical Engineering
HOMETOWN: Nkongsamba, Cameroon
CAREER GOAL: Pediatric medicine.
FUN FACT: Loves to sing and work with children.

Travis Puckett
MAJOR: Computer Science
HOMETOWN: Chesterfield, Virginia
CAREER GOAL: Data science for health care.
FUN FACT: Started out as a biology major but fell in love with coding.

Jessi Shaffer
MAJOR: Electrical Engineering and Applied Mathematics; Minor in Creative Writing
HOMETOWN: Amelia Courthouse, Virginia
CAREER GOAL: Work with green energy.
FUN FACT: Is in the Historical European Martial Arts Club learning German longsword fencing.

VIRTUAL REALITY LAB

The Department of Computer Science is humanizing software in a new virtual reality lab that opened in September 2017. The Modern Heuristics Research Group Virtual Reality (MHRG VR) Lab uses human-machine interaction to support research in visual data mining, robotics, personnel training and more.

"Visualization has changed its meaning over the last 10 years," said Milos Manic, Ph.D., professor of computer science and director of the lab. "It's become less a discipline in itself and more a mechanism to solve problems and bring about understanding in a more intuitive way."

A spreadsheet with thousands of numbers or data points, for example, can be transformed in this lab into a detailed, multicolor 3D shape — a self-organizing data map rich with new insights. Programs that run on data-mining algorithms detect and display previously invisible patterns in huge quantities of data.

Visualization goes both ways in this lab, with programs that let robots "see," track and replicate a human's movements. Using demonstrations, an expert can program a robot to perform specialized or hazardous tasks. "We can help develop applications for remote welding, for instance, or nuclear waste treatment within a nuclear reactor," Manic said. "We are also looking at these applications for training individuals with autism to deal more effectively with everyday situations."

Force-feedback lets lab users touch and feel objects that exist only in software. When examined with a specialty joystick, the surface of a sphere on a screen can become alternately rough, smooth or magnetic — or its consistency can suddenly turn molasses-like.

Users can play catch with such technologies. They can also use them to design programs that train drivers to operate heavy vehicles in a safer, more fuel-efficient way. Manic, an expert in computer science applications for fuel efficiency, conducts research in these areas with the U.S. Department of Energy's Idaho National Laboratory. "Using these applications, plus neural networks and machine-learning algorithms, we can achieve fuel efficiency improvements ranging from 5 to 15 percent," he said.

The lab's devices can even create machine-human experiences that go beyond the five senses.

"We have the capability to track human thoughts with different EEG [electroencephalography] devices, so we can drive a robot remotely, wirelessly, with thought alone," Manic said, noting that this has important implications for users with disabilities. Although these machines may sound like the stuff of the future, Manic emphasized the here-and-now. "This is not science fiction," he said. "This is real."

ADVANCING HYPERSONICS

Mohamed Gad-el-Hak, Ph.D., professor emeritus in the Department of Mechanical and Nuclear Engineering, and collaborators from the University of Peking have reported a new aerodynamic heating mechanism that yields insights vital to the design of hypersonic vehicles and the realization of hypersonic travel. Through theory, experiments and numerical simulations, the investigators have expanded the understanding of hypersonic heating phenomena in Earth's boundary layers. The National Science Review highlighted the study in its 2018 research review, calling it a "new principle for aerodynamic heating."

MANAGING THE POWER GRID

Sherif Abdelwahed, Ph.D., professor in the Department of Electrical and Computer Engineering, is developing a computing solution for today's large, complex power system. With funding from the National Science Foundation, Abdelwahed is designing a platform to conduct rapid and accurate power system analyses using high-performance computing systems. His method comprises a smart positioning system monitor to track the energy usage by individuals in a building. The system aims to enhance the economics, reliability and stability of electric power systems and accelerate deployment of other smart grid technologies.

LEVERAGING ELECTRON SPIN

With National Science Foundation funding, Supriyo Bandyopadhyay, Ph.D., Commonwealth Professor in the Department of Electrical and Computer Engineering, and Jayasimha Atulasimha, Ph.D., Qimonda Professor in the Department of Mechanical and Nuclear Engineering, are using spin properties of electrons to design highly efficient technologies — a process called spintronics. Electronics uses electron charge to store, process and communicate information. Spintronics, by contrast, uses the "up" or "down" direction of electron spin to store or transmit bits of information in ones or zeros.

OUTSTANDING FACULTY AWARD

Supriyo Bandyopadhyay, Ph.D., Commonwealth Professor in the Department of Electrical and Computer Engineering, received the 2018 Virginia State Council of Higher Education for Virginia (SCHEV) Outstanding Faculty Award. This award is the state's highest honor for faculty at Virginia's public and private colleges and universities. He also received VCU's 2017 University Award of Excellence. Presented annually to one of VCU's approximately 2,300 faculty members, it is among the highest honors the university can bestow.

ORIGIN OF ALZHEIMER'S

A "twist of fate" that is minuscule even on the molecular level may cause the development of Alzheimer's disease, VCU researchers have found. Observations of molecules called monomers, which are present in the brain, have revealed valuable insights into the disease's pathway. Michael Peters, Ph.D., a professor in the Department of Chemical and Life Science Engineering, found that monomers with two additional links could lead to Alzheimer's. That addition of the naturally occurring amino acids "causes a catastrophe," he said.

35 UNDER 35 AWARD

Nastassja Lewinski, Ph.D., assistant professor of chemical and life science engineering, won an American Institute of Chemical Engineers (AIChE) 35 Under 35 Award. She was honored as an outstanding young professional AIChE member for making significant contributions to the organization and to the chemical engineering profession. Her research examines nanoparticle design and safety using in vitro and informatics approaches. Asked what she enjoys most about her job, Lewinski said, "I enjoy mentoring students and watching them grow."

NO WIRE LEFT BEHIND

A multidisciplinary team from the VCU College of Engineering and the VCU School of Medicine wants to make it impossible to leave a wire inside the body accidentally during common medical procedures.

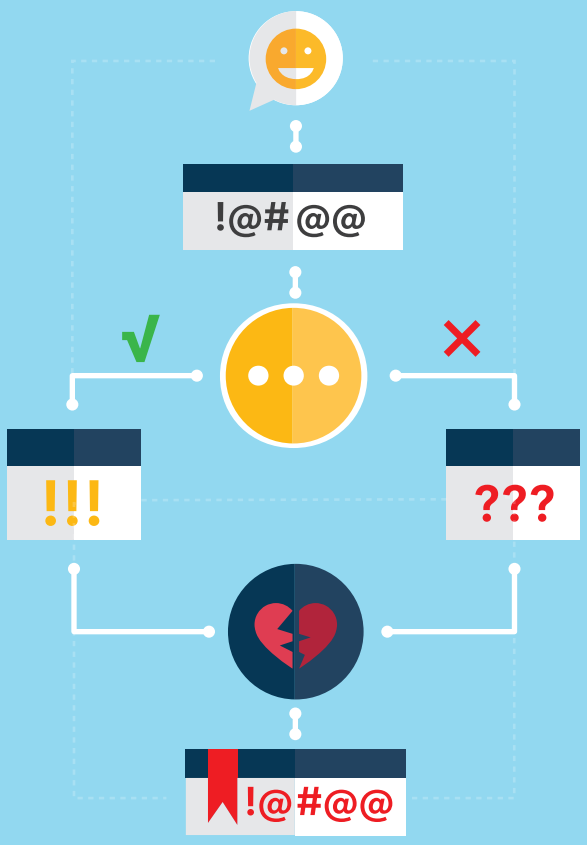
The team has designed a novel alarm to improve safety when placing a central venous catheter, a tube that goes into a large vein to give blood or medications. Typically, physicians and other clinicians first insert a wire, then slide the catheter over this "guidewire." W. Paul Murphy, M.D., assistant professor in the Department of Anesthesiology in the VCU School of Medicine, said the guidewire is accidentally left behind in one of 3,000 procedures.

Inadvertently leaving anything inside a patient during any procedure is a serious but preventable complication, labeled a "never event" by federal insurers. These never events are publicly reported and costly in terms of dollars, patients and reputations.

Murphy is collaborating with Bennett Ward, Ph.D., associate professor at the VCU College of Engineering, and Hilton Bennett, a graduate student at VCU's da Vinci Center. The project, dubbed "No Wire Left Behind," was awarded research funding through VCU's Quest Commercialization Fund, which is dedicated to propelling VCU inventions to market.

Bennett, a VCU mechanical engineering major who graduated in 2016, said if a wire is left behind, "it's a risky situation for the patient." The patient must undergo an additional procedure to have it removed. A clip with lights and a buzzer attaches to the wire to serve as a constant reminder to the physician or clinician that the wire is inside the patient's body.

The project is one of several being undertaken by a Vertically Integrated Project (VIP) team formed in the fall of 2015 to improve critical patient care provided by anesthesiologists and nurse anesthetists through various engineered solutions.



TWITTER MEETS DATA SCIENCE

Bartosz Krawczyk, Ph.D., Bridget McInnes, Ph.D., and Alberto Cano, Ph.D., all assistant professors of computer science, are developing algorithms that can help the online news and social networking service Twitter detect attitudes and feelings — and even identify hate speech. They have designed a robust system to computationally determine whether a tweet is positive or negative. This process, called sentiment analysis, is valuable to marketers and political consultants. It is also used to monitor social phenomena and spot potentially dangerous situations.

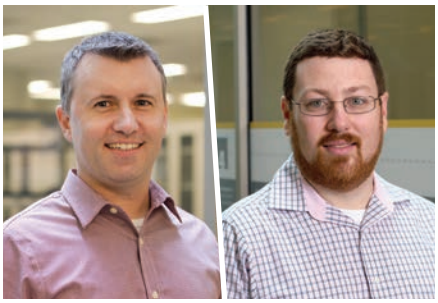
Sentiment analysis is complicated, especially in social media where high traffic, misspellings, emojis and sarcasm abound. Is a tweet that says, "Gee, that's great" sincere or shady? Their system can tell because it leverages the distinct specialties of each researcher. Krawczyk brings expertise in algorithms that learn from and make predictions on data. McInnes is a specialist in interactions between computers and human languages. Cano specializes in big data, essential for the 6,000-tweets-per-second Twitter space. Undergraduate computer science majors Abigail Byram and Andriy Mulyar are also participating in this research through the Dean's Undergraduate Research Initiative (DURI).

ASME FELLOW

Jayasimha Atulasimha, Ph.D., Qimonda Professor in the Department of Mechanical and Nuclear Engineering, has been named a fellow of the American Society of Mechanical Engineers (ASME). Fellowship is conferred on three percent of the members of ASME, which is active in 158 countries. This honor recognizes Atulasimha's pioneering contributions to the field of straintronics, an extremely energy-efficient nanomagnetic computing program that uses strain to manipulate the magnetic state. He was also cited for ongoing leadership in the smart materials community.

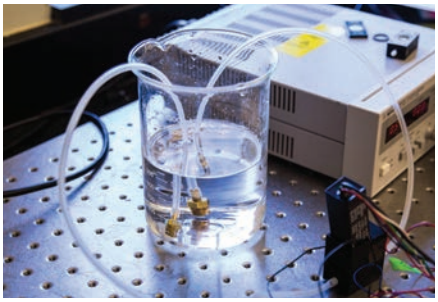
MAKING CODING ACCESSIBLE

Dianne T. V. Pawluk, Ph.D., associate professor in the Department of Biomedical Engineering, is developing technology to provide a computer programming interface that visually impaired high school students can use to learn computational thinking and programming languages — and collaborate with students who are sighted. Pawluk is collaborating with Joshua Miele, Ph.D., of the Smith-Kettlewell Eye Research Institute in San Francisco, on a project funded by a $1 million grant from the National Science Foundation Division of Research on Learning.



EXPLAINING CELL BEHAVIOR

A study by researchers in the Department of Biomedical Engineering enhances understanding of a cell's response to mechanical cues from its surrounding environment, a key regulator of cell function. The research by assistant professor Seth Weinberg, Ph.D., and associate professor Christopher Lemmon, Ph.D., is part of a project funded by a $1.8 million grant from the National Institutes of Health. The Biophysical Journal's "New and Notable" feature called it "a great advance in modeling cell behavior in mechanically complex microenvironments."



IMPROVING WATER TESTING

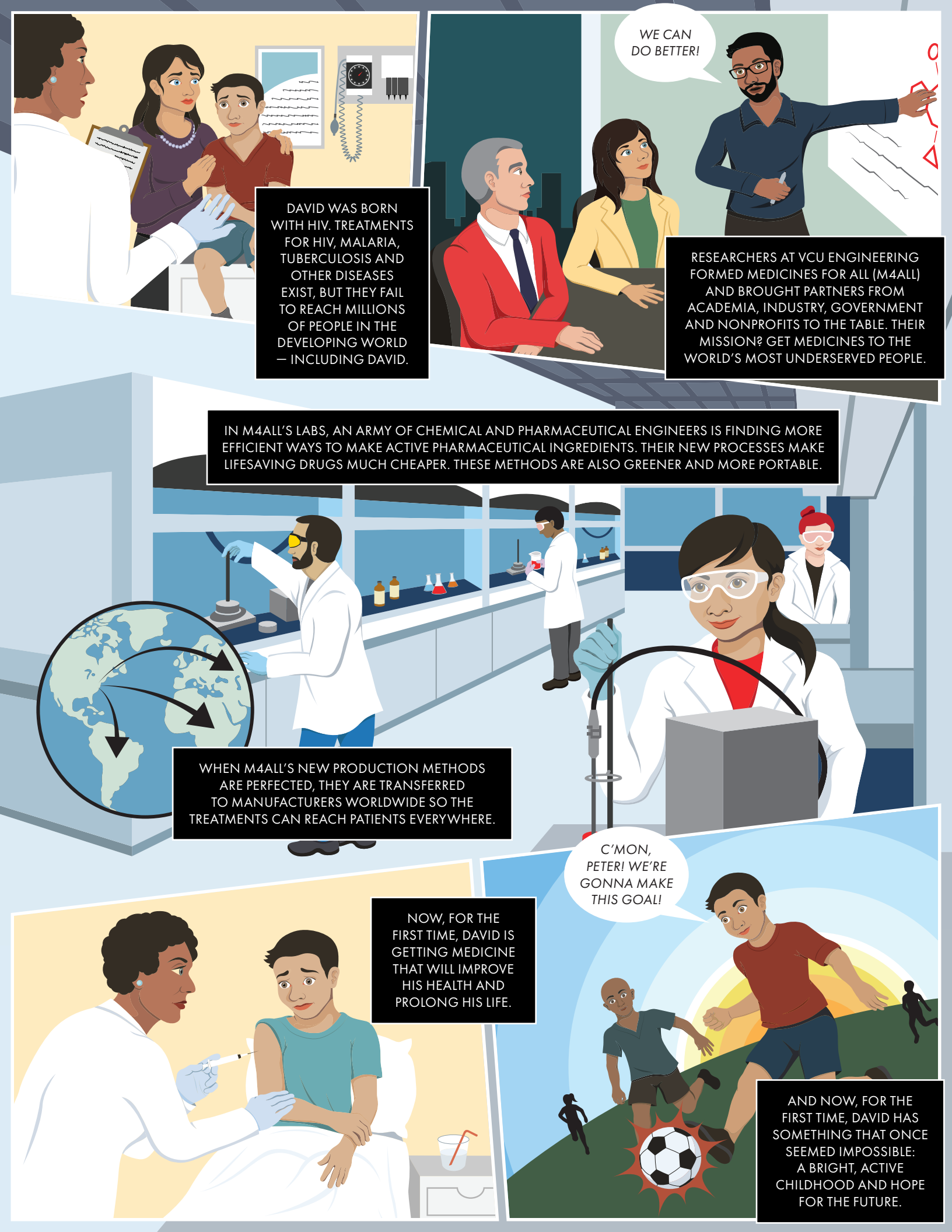
Elevated levels of uranium in water supplies are an environmental safety concern, but current detection methods are cumbersome, costly and time consuming. Gary C. Tepper, Ph.D., chair of the Department of Mechanical and Nuclear Engineering, and Ph.D. student Brandon Dodd addressed this challenge with a novel portable device that streamlines how uranium in water is measured. Their new patented technology is more sensitive than current technologies and able to detect trace concentrations of uranium in water supplies.

MEDICINAL AEROSOLS

P. Worth Longest, Ph.D., the Louis S. and Ruth S. Harris Exceptional Scholar Professor in the Department of Mechanical and Nuclear Engineering, is developing dry powder medicinal aerosols for infants with respiratory disorders. Longest and Michael Hindle, Ph.D., Peter R. Byron Distinguished Professor in the VCU School of Pharmacy, are both principal investigators on this National Institutes of Health-sponsored research. Their system avoids risks associated with intubation of infants and makes possible efficient, rapid dose delivery in a convenient dry powder platform.

A SMARTER CANE

Cang Ye, Ph.D., professor in the Department of Computer Science, is designing a specialty cane for people with visual impairments. Ye's device, called RoboCane, is being developed with funding from the National Institutes of Health. It detects potential obstacles and can alert the user with voice prompts. It also intuitively conveys the desired travel direction. Digital floor plans can be loaded into RoboCane's computer for navigation. The device can understand the user's verbal commands and give feedback through a wireless earpiece.


DAVID WAS BORN WITH HIV. TREATMENTS FOR HIV, MALARIA, TUBERCULOSIS AND OTHER DISEASES EXIST, BUT THEY FAIL TO REACH MILLIONS OF PEOPLE IN THE DEVELOPING WORLD — INCLUDING DAVID.
WE CAN DO BETTER!
RESEARCHERS AT VCU ENGINEERING FORMED MEDICINES FOR ALL (M4ALL) AND BROUGHT PARTNERS FROM ACADEMIA, INDUSTRY, GOVERNMENT AND NONPROFITS TO THE TABLE. THEIR MISSION? GET MEDICINES TO THE WORLD'S MOST UNDERSERVED PEOPLE.
IN M4ALL'S LABS, AN ARMY OF CHEMICAL AND PHARMACEUTICAL ENGINEERS IS FINDING MORE EFFICIENT WAYS TO MAKE ACTIVE PHARMACEUTICAL INGREDIENTS. THEIR NEW PROCESSES MAKE LIFESAVING DRUGS MUCH CHEAPER. THESE METHODS ARE ALSO GREENER AND MORE PORTABLE.
WHEN M4ALL'S NEW PRODUCTION METHODS ARE PERFECTED, THEY ARE TRANSFERRED TO MANUFACTURERS WORLDWIDE SO THE TREATMENTS CAN REACH PATIENTS EVERYWHERE.
NOW, FOR THE FIRST TIME, DAVID IS GETTING MEDICINE THAT WILL IMPROVE HIS HEALTH AND PROLONG HIS LIFE.
C'MON, PETER! WE'RE GONNA MAKE THIS GOAL!
AND NOW, FOR THE FIRST TIME, DAVID HAS SOMETHING THAT ONCE SEEMED IMPOSSIBLE: A BRIGHT, ACTIVE CHILDHOOD AND HOPE FOR THE FUTURE.

medicines for all

With a historic grant and expanded capabilities, VCU's Medicines for All Institute is on track to improve pharmaceutical engineering — and save lives — around the world.

THE LARGEST PRIVATE GRANT IN VCU HISTORY

The College of Engineering was awarded a $25 million grant in 2017 from the Bill & Melinda Gates Foundation to establish the Medicines for All Institute (M4ALL) and to fund the institute's work on a wide range of essential global health treatments. With this grant, the institute can help increase access to lifesaving medications for HIV/AIDS, malaria, tuberculosis and other diseases around the world. This is the largest grant from a private entity in VCU history.

Barbara D. Boyan, Ph.D., the Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering, was joined by then-Gov. Terry McAuliffe and VCU President Michael Rao, Ph.D., in making the announcement at the college's new facilities at the VA Bio+Tech Park.

"I'm really proud of this. This is a big deal here in Virginia," McAuliffe said. "The research projects that VCU does directly benefit the Commonwealth of Virginia, and that's a big distinction. I am so appreciative of all the great work that has gone on here and appreciate everything and all you've done."

THE STEADY EXPANSION OF A BIG IDEA

Over the previous four years, the Gates Foundation awarded nearly $15 million to Medicines for All, founded by B. Frank Gupton, Ph.D., the Floyd D. Gottwald Jr. Chair and chair of VCU's Department of Chemical and Life Science Engineering. Gupton will continue to lead the new Medicines for All Institute and serve as principal investigator. M4ALL has developed an innovative model that reduces the cost of manufacturing AIDS treatments such as nevirapine by accelerating the creation of more efficient ways to synthesize active pharmaceutical ingredients. M4ALL also works closely with the Clinton Health Access Initiative and other implementation partners to transfer the new processes to manufacturers so that more medications can reach communities in need.

"The concept started with a simple idea to increase access to global health care," Gupton said. "We have to use 21st century capabilities to make these drugs and make them affordable to everyone."

The success of Gupton's team was evident from the initial grant. For instance, it was able to reduce the cost of HIV drugs by more than 10 percent in less than one year.

"The Gates Foundation gave us $4.4 million to work on this first target molecule," Gupton said. "If we reduced the cost 10 percent, then the payback period on the $4.4 million would be about a year. With now sustained savings of more than 10 percent, the payback period has been even shorter."

The Gates Foundation was so pleased they wanted Gupton to work on more than one drug at a time.

"And I said 'No I can't do that, there's only one of me.' And then they said, 'Well, what if we were able to give you the funding to be able to recruit additional people to come in and work in parallel with you on other drugs,'" said Gupton.

In the new M4ALL Institute, Gupton and his team can look at multiple drugs in parallel. The institute will also work on an additional 13 global health drugs over the next five years, both in market and in development.

> "THE CONCEPT STARTED WITH A SIMPLE IDEA TO INCREASE ACCESS TO GLOBAL HEALTH CARE. WE HAVE TO USE 21ST CENTURY CAPABILITIES TO MAKE THESE DRUGS AND MAKE THEM AFFORDABLE TO EVERYONE."
>
> *B. Frank Gupton, Ph.D.*

BUILDING THE TEAM

Gupton's experience and reputation have allowed him to attract big talent to the Medicines for All Institute. Prior to coming to VCU, Eugene Choi, Ph.D., executive director of the institute, spent 10 years at the U.S. Department of Defense's Defense Advanced Research Projects Agency (DARPA), where he helped create new programs to develop innovative and disruptive technologies.

From left: **B. Frank Gupton, Ph.D. and Perrer Tosso, Ph.D.**

> **THERE AREN'T THAT MANY PEOPLE** IN THE WORLD WHO THINK THE WAY FRANK DOES IN TERMS OF CHEMISTRY.
>
> *Eugene Choi, Ph.D.*

The two met a few years ago and stayed in contact. Gupton's vision aligned with Choi's interests, which helped attract Choi to M4ALL.

"There aren't that many people in the world who think the way Frank does in terms of chemistry," Choi said. "Most people think chemistry has to be more complicated than it needs to be. Frank, largely based on his industry experience, realizes that you have to be as practical and simplistic as you can in order to drive down costs for medicines. His foresight in terms of knowing where the major opportunities are and identifying major cost drivers for drug manufacturing is really key here."

In all, the institute's 30-member team at VCU includes Thomas Roper, Ph.D., VCU Engineering's director of pharmaceutical engineering and CIT Eminent Scholar; Tyler McQuade, Ph.D., VCU Engineering professor and M4ALL principal; Bruce V. Thomas J.D., senior adviser and expert in development and scale-up of health care improvement in the developing world — plus dedicated research professors, postdocs and graduate students.

A MEETING OF THE MINDS: THE INAUGURAL M4ALL SUMMIT

In December 2017, the inaugural Medicines for All Summit convened leaders from academia, industry, government and nonprofits to further the urgent goal of increasing access to global health care to save more lives.

The two-day summit centered on why access to cost-effective medicines is such a challenge and how technology-based solutions can improve global access to affordable medicines. Researchers from universities including the Massachusetts Institute of Technology, South Africa's Nelson Mandela Metropolitan University and VCU joined leaders from the Gates Foundation, the Clinton Health Access Initiative, USAID and major pharmaceutical manufacturers to forge paths forward. Undergraduate and graduate students from VCU, as well as chemistry students from John Marshall High School in Richmond, also participated in the event.

The summit urged transfer of knowledge and ideas, in addition to green manufacturing and higher production output. "Our primary activities are transforming pharmaceutical manufacturing, reinventing the supply chain — and creating the next generation of global scientists and engineers," Choi said. "We now get approached by students worldwide who are interested in what we're doing. It's a self-feeding ecosystem."

This ecosystem is set to expand as M4ALL scales up to tackle additional medicines including treatments for HIV/AIDS, malaria and tuberculosis.

"This is not just about chemistry, it's about vision and the right players," Gupton said. "We are not just bringing molecules together. We're bringing people together to solve a problem."

NSF AWARD

The Virginia-North Carolina Louis Stokes Alliance for Minority Participation (LSAMP) has received a third five-year, $5 million National Science Foundation grant to continue its work in boosting the number of underrepresented minorities in STEM. Co-principal investigator Rosalyn Hobson Hargraves, Ph.D., associate vice president, Division for Inclusive Excellence and associate professor in the Department of Electrical and Computer Engineering and the VCU School of Education, will examine the impact of co-curricular experiences on students' STEM identity and academic self-efficacy.

SCIENCE AND SILK PROTEINS

Vamsi Yadavalli, Ph.D., associate professor in the Department of Chemical and Life Science Engineering, received a grant under the Fulbright Research/Teaching Scholar program for his project "The New Silk Road: Inventive Applications for an Ancient Material." From January through July 2018, Yadavalli worked with researchers at the University of Trento, Italy, to study how silk proteins from silkworms and orb-weaving spiders can be harvested for applications in photonics, bioelectronics, drug delivery vehicles and tissue scaffolds for growing artificial organs.

IEEE PIONEER

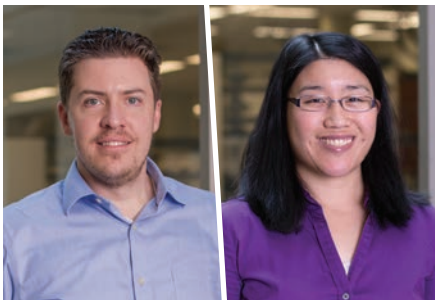
Robert J. Mattauch, Ph.D., dean emeritus of the VCU College of Engineering and the founding chair of the Department of Electrical and Computer Engineering, has received the 2018 Microwave Pioneer Award of the IEEE Microwave Theory and Techniques Society (MTT-S). The award is given for a career of meritorious achievement and outstanding technical contribution in the field of microwave theory and techniques. Mattauch's research focus is radio astronomy and molecular spectroscopy detection elements. He was the second dean of VCU Engineering, from 1999 to 2006.

PARKINSON'S RESEARCH

With a $1 million grant from the Michael J. Fox Foundation, Paul A. Wetzel, Ph.D., associate professor of biomedical engineering, and Mark Baron, M.D., professor of neurology at the VCU School of Medicine, are testing a diagnostic tool for Parkinson's disease. The noninvasive eye-tracking device they invented uses infrared light to follow a patient's eye movement as the patient attempts to fix his or her gaze on a screen-displayed object. While normal eye movements are highly regular and follow well-defined patterns, neurological disorders such as Parkinson's disease alter eye movements.

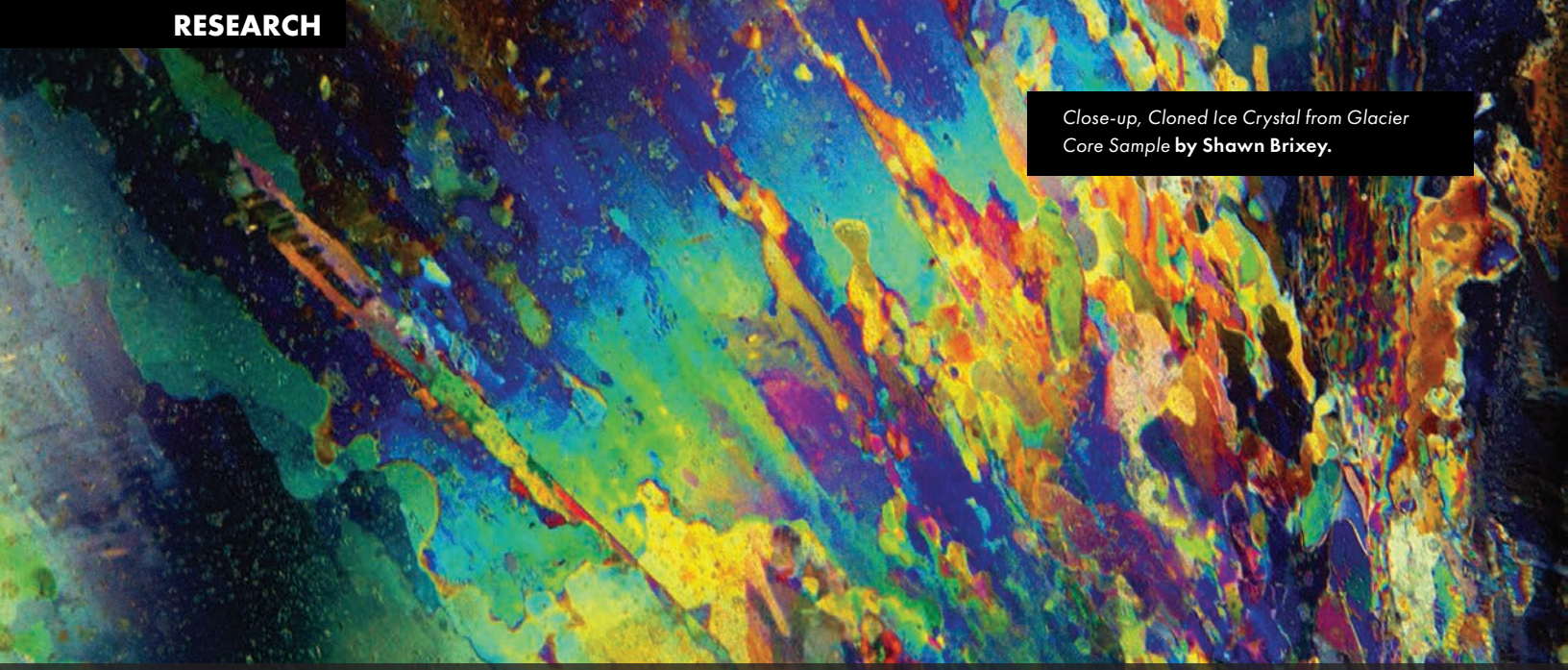
ASEE AWARD

Afroditi V. Filippas, Ph.D., and Ümit Özgür, Ph.D., received the ASEE Electrical and Computer Engineering Division's national award for Outstanding Diversity Paper for 2017. Their paper "Capstone: Rules of Engagement" analyzed VCU's signature culminating engineering experience, with an eye toward the program's strong track record of building collaboration. It emphasized best design practices overall, with a focus on teamwork that included a discussion of diversity, both in terms of gender and race and also in terms of competencies, talents and technical backgrounds.



NSF CAREER AWARDS

Daniel Conway, Ph.D., assistant professor of biomedical engineering, and Christina Tang, Ph.D., assistant professor of chemical engineering, received National Science Foundation CAREER Awards for 2017. Conway received the award for his research on how cells experience mechanical forces and the role those forces play in cell function. Tang received the award for her work in nanoscale chemical processing to achieve complex chemical products, including pharmaceuticals with significantly reduced hazardous waste. VCU Engineering's faculty now hold a total of seven NSF CAREER Awards.



Close-up, Cloned Ice Crystal from Glacier Core Sample **by Shawn Brixey.**

THE HYBRID DEAN

Shawn Brixey, who became VCUarts dean in 2017, is also an affiliate professor at VCU Engineering. The appointment speaks to the two programs' relationship and VCU's creative, collaborative, innovative and entrepreneurial engineering culture.

Courtesy of VCU University Relations

Before coming to VCU, Brixey was dean of the School of the Arts, Media, Performance and Design at York University in Toronto. His decision to relocate was motivated by Richmond's and VCU's interdisciplinary energy.

Deans are like venture capitalists, Brixey said. When looking to make career changes, they often look at an institution's potential, their ambition, the lives of consequence the faculty and students want to lead, and the impact their community aspires toward.

Brixey found that potential in Richmond, calling it the right place at the right time with the right people, where lines converge. He saw those lines converging at VCU, too, and wanted to be part of it.

At VCU, we organically come together and continually ask, 'What does it look like if we join forces and address issues collectively, collaboratively?' … We're all active, integrated partners in this extraordinary enterprise to discover new knowledge."

Brixey's engineering lab in Bio+Tech Eight looks like some of the other VCU Engineering labs, with optical isolation tables, lasers, video microscopes, circuit board printers, oscilloscopes and computer numeric control machine tools. He is perhaps the first art school dean to have a laboratory rather than a studio. To be sure, Brixey is a rarity — equal parts artist and scientist.

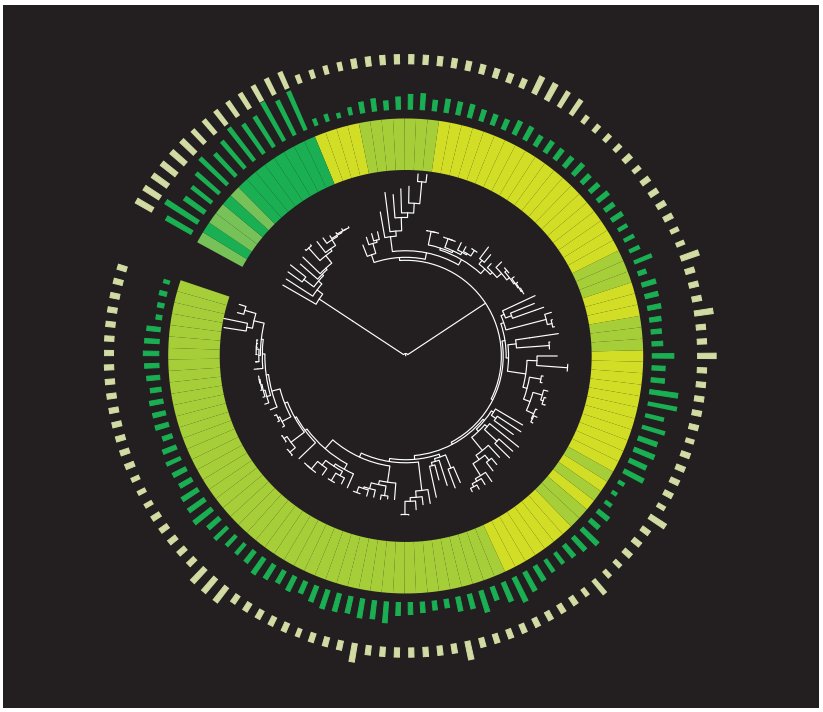
With a Massachusetts Institute of Technology-education, Brixey is equally comfortable among engineers and artists. As a hybrid of the two, he's recognized that scientists share the same sense of awe and wonder, derived from the same place, as artists.

"We use different methodology and we approach creative problem solving differently," he said. "But one of our fundamental goals is as we experience the structure and behavior of the world around us through observation, experiment, intervention and expression, we both want to discover what it means to be human and then document that in ways that no one's ever really imagined."

Brixey brings the two disciplines together in a way that is ideal for engineering, said Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering.

"He comes from the tech world and understands that art and technology are not so different," Boyan said. "His expertise in novel interfaces, and research in visualization of complex ideas and systems is a major focus of both engineering and the arts. He knows that it's not enough to write brilliant computer programs — you have to make them something people want to use. You have to make them beautiful. This is what Steve Jobs taught, too. Technology must be beautiful."

UNLOCKING THE SECRETS OF PROTEINS



Proteins are the building blocks of life and biological agents. They are drivers of growth and development and the spread of viruses and bacteria, and have key roles in disease pathways and virtually all cellular functions. As scientists gain knowledge about proteins, the mechanisms behind biological mysteries are revealed.

To help shed light on the workings of proteins, Lukasz Kurgan, Ph.D., vice chair and Qimonda Professor in the Department of Computer Science, has developed a series of bioinformatics programs to assist biologists in developing insights into the functions of intrinsically disordered proteins. This group of proteins lacks a fixed structure, which means they are totally or partially flexible and amorphous. Kurgan's team has been awarded a $500,000 grant from the National Science Foundation to continue its innovative work.

Over the last several decades, scientists have sequenced over 115 million unique proteins, structured and intrinsically disordered alike, but still don't know what the vast majority of them do. As more proteins are discovered, more sophisticated computer programs must be developed to help determine their functions.

If a protein is disordered, biologists turn to programs built by Kurgan and others that use predictive models to generate workable hypotheses on the protein's function.

"We have manually curated less than one percent of these proteins in order to better understand them, and right now there's well over 110 million to solve. A program can solve these proteins faster than a single human and can help researchers speed up hypothesis generation," Kurgan said.

AIMBE INDUCTIONS

Four VCU Engineering faculty members have been elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows, bringing the engineering college's total number of fellows to 12. AIMBE fellows represent the top two percent of the medical and biological engineering community. VCU Engineering's new AIMBE fellows are:

L. Franklin Bost, M.B.A., IDSA

Executive associate dean for innovation and outreach, director of the VCU Institute for Engineering and Medicine and professor in the Department of Mechanical and Nuclear Engineering.

Krzysztof J. Cios, Ph.D., M.B.A., D.Sc.

Professor and chair, Department of Computer Science.

B. Frank Gupton, Ph.D.

Floyd D. Gottwald Jr. Chair and chair, Department of Chemical and Life Science Engineering.

Lukasz Kurgan, Ph.D.

Qimonda Professor and vice chair, Department of Computer Science.

WOMEN in ENGINEERING

Stereotype threat is a self-fulfilling phenomenon in which people — usually women and minorities — think they are at risk of being characterized negatively and end up conforming to those very stereotypes. Studies have shown that even mentioning gender caused girls to perform worse than boys on math tests, said Lorraine Parker, Ph.D., director of diversity and student programs for VCU Engineering.

Parker cites one study in which both boys and girls took a math test and performed the same. Later, they were given another test but were asked to indicate their gender at the top of the paper. The girls tested much lower this time.

"It was just a very subtle reminder that, 'Hey, you're a girl,' and suddenly the women did far worse," Parker said. "[Society]

says that women aren't as good at math as boys. And if you remind them of that, even indirectly," it can have detrimental effects. "You should encourage everybody in the class as if there's no difference between them," she said.

The retired VCU computer science professor had stereotype threat studies on her mind when Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering, recruited her back to VCU in 2013 to head the college's diversity programs.

Nationally, women made up 19.8 percent of engineering students in bachelor's degree programs in 2014, according to the National Science Foundation. At VCU Engineering, 25.3 percent of students are female.

Charged with increasing enrollment and retention of minorities — especially women — in engineering, Parker and a committee received an $8,000 grant in 2015 from the National Center for Women and Information Technology Extension Services for Undergraduate Programs. By the end of the 2015-16 academic year, new women enrollments in computer science had increased 125 percent over 2013-14 numbers. New women enrollments in electrical and computer engineering increased 450 percent for the same period.

SINCE 2012, THE NUMBER OF FEMALE UNDERGRADS HAS INCREASED BY **36%**

83% MORE DEGREES AWARDED TO FEMALE STUDENTS SINCE 2009

The total percentage of female-declared majors in both programs also increased during the period. Female computer science majors went from 12.6 percent in 2013-14 to 18.7 percent in 2016-17. Female electrical and computer engineering majors went from 10 percent to 14 percent in the same period.

Also on the committee were Bridget McInnes, Ph.D., assistant professor, Department of Computer Science; Afroditi V. Filippas, Ph.D., associate dean for undergraduate studies and professor in the Department of Electrical and Computer Engineering; Zhifang Wang, Ph.D., assistant professor, Department of Electrical and Computer Engineering; Rosalyn Hobson Hargraves, Ph.D., associate professor, Department of Electrical and Computer Engineering and associate vice president, Division of Inclusive Excellence and Mark Meadows, director of student recruitment.

PEER-TO-PEER MENTORING

To provide continuous support for women students, the college launched the Vertically Integrated Networking for Engineers (VINE) program in 2015. It connects students by hosting intimate social gatherings within the same discipline, across years of study. Ideally, each group is made up of a senior, a junior, a sophomore and a first-year student.

The VINE program is currently open to women in the following disciplines: computer science, computer engineering, electrical engineering, nuclear engineering and mechanical engineering. The groups are encouraged to meet for coffee around town once a month — with the college picking up the tab.

AN ENGINEER YOU SHOULD KNOW

In recognition of Parker's efforts in these areas, SWE, the magazine of the Society of Women Engineers, featured her as a "Woman Engineer You Should Know." The magazine's annual feature highlights women engineers throughout the country who are making meaningful contributions in the workplace and in our communities.

NASA COLLABORATIONS

VCU Engineering is collaborating with NASA on research that has far-reaching applications. By going beyond Earth's orbit to gain insights on topics as diverse as orthopaedics, chemical behavior and new protective materials, VCU investigators' work is enhancing the effectiveness of space exploration — and improving life closer to home.

ADVANCED MATERIALS FOR NASA SPACE PROJECT

To explore more deeply into our solar system, NASA wants new spacecraft to be made of advanced ultra-high strength material — and has tapped a university-led team to deliver it.

The new NASA-sponsored multidisciplinary Space Technology Research Institute (STRI) will incorporate the work of Ibrahim Guven, Ph.D., assistant professor in the Department of Mechanical and Nuclear Engineering, to ensure that this cutting-edge material won't fail.

The STRI focuses on developing aerospace structural material for next-generation transit vehicles, habitats, power systems and other exploration systems. Guven is part of Ultra-Strong Composites by Computational Design (US-COMP), which is made up of 22 faculty members from 11 universities as well as industry partners and the U.S. Air Force Research Lab. The team will receive up to $15 million over five years.

The group intends to deliver a composite material that makes use of engineered carbon nanotubes and will be much lighter — but much stronger — than what is currently available.

Guven said, "Whenever you talk about a spacecraft, especially a manned spacecraft, you have to talk about exit from and re-entry to Earth. We want to be able to make sure that the new material that this STRI is promising to deliver can have superior impact resistance and resistance to failure."

Computational modeling allows researchers to predict, based on physics and mathematical formulations, whether under certain conditions the material will break, and where. "It provides a virtual laboratory," Guven said. Being able to test different hypotheses quickly guides experimental work, saving money and time.

The project is led by Michigan Technological University. Other members of the institute include Massachusetts Institute of Technology, Johns Hopkins University, Georgia Institute of Technology and University of Utah. Funding for the institute comes from NASA's Space Technology Mission Directorate, responsible for developing new technologies.

BUILDING BETTER RADIATION SHIELDS

Research by Daniel Bond, a doctoral student in the Department of Mechanical and Nuclear Engineering, will help NASA engineer better barriers against the much-higher radiation levels astronauts will face in deep space. As the agency prepares to send crews beyond Earth's lower orbit, it needs spacecraft that protect against strong space radiation. Bond is lead author on the first comprehensive study of the 47 materials most commonly considered for radiation shielding. The best materials

all contained polyethylene — the polymer used in grocery bags, shampoo bottles, toys and bulletproof vests. To support NASA's program to build new vehicles in space, the study also includes two unusual materials: lunar and Martian regolith — soil from the moon and Mars.

SPACE RADIATION'S IMPACTS ON BONE AND MUSCLE HEALTH

New research by Henry J. Donahue, Ph.D., chair of the Department of Biomedical Engineering and College of Engineering Foundation Professor at the VCU College of Engineering, suggests that space radiation may cause astronauts in outer space to lose additional bone, but not more muscle.

Donahue is principal investigator of a project funded by NASA and the National Space Biomedical Research Institute. His findings raise intriguing questions about the relationship between bone and muscle, especially for humans on Earth dealing with age-related bone and muscle loss.

While in the reduced gravity of space, astronauts lose bone and muscle from their legs, hips and lower backs. As NASA prepares for deep space travel, astronauts will also face increased, prolonged exposure to space radiation.

In the first study of its kind, Donahue's team investigated the combined impact of space radiation and microgravity on bone and muscle, hypothesizing that radiation would exacerbate bone and muscle loss caused by microgravity. Researchers examined mice whose movements were restricted — an experience similar to microgravity — and those exposed to simulated space radiation. What they found was that while microgravity alone led to both bone and muscle loss, radiation alone did not. "Radiation plus microgravity amplifies the negative effect of microgravity on bone," Donahue said, "but does not affect muscle loss. It's as if exposure to radiation itself doesn't affect bone, but it makes it more sensitive to the negative effects of microgravity."

The study suggests that astronauts on extended space travel missions would have significant bone and muscle complications.

The loss of bone and muscle experienced by astronauts in microgravity is similar to what happens as people age, Donahue said. "Understanding the relationship in microgravity between bone and muscle has relevance to the effect of aging on muscle and bone."

FOAMS AND EMULSIONS IN SPACE

James Ferri, Ph.D., professor of chemical and life science engineering, is part of an international team of researchers collaborating with NASA and the European Space Agency (ESA) to send experiments on the behavior of foams and emulsions to the International Space Station (ISS). The team's findings will be transferred to industry for applications ranging from medicine to food science to a world of consumer goods.

Ferri came to VCU from Lafayette College in 2017. His expertise includes dispersed fluid systems, and he sees space as the ultimate microgravity laboratory for designing innovations to improve life on Earth.

"NASA sponsors research for space and research in space. My work falls in the latter category," he said. "You can study chemistry in a whole new way when you turn off gravity, and in space, you can do that."

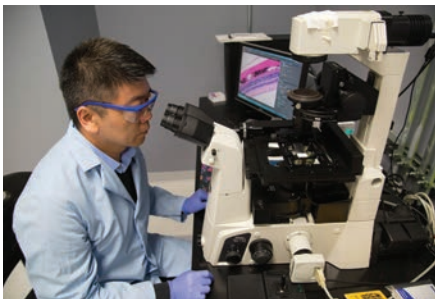
To understand why turning off gravity is appealing to researchers, it's helpful to look at how foams and emulsions are made. An emulsion is a liquid dispersed into a liquid. A foam is a gas dispersed into a liquid. Density is a key consideration in developing these combinations — it distinguishes cappuccino from café au lait and pudding from mousse. The density difference also tends to make foams and emulsions unstable.

"You can say, 'Let's study the chemical aspects of dispersed fluid systems,'" Ferri said. "But on Earth, many of them don't exist long enough to study well. Foams disintegrate and emulsions separate."

Outside Earth's gravity, however, an oil-and-vinegar salad dressing stays mixed, the head on a Guinness stout doesn't drain — and researchers can more thoroughly study the chemical and physical principles that determine the stability of dispersed fluids. Data from these experiments will help generate better foam and emulsion dynamics models for industrial applications including safer, more stable and greener products.

NAI FELLOW

Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Jr. dean of the VCU College of Engineering, was inducted in 2016 as a National Academy of Inventors (NAI) Fellow. Boyan is inventor on 23 U.S. and multiple international patents. Her inventions focus on innovative ways to treat musculoskeletal defects by harnessing the body's own regenerative potential. Notable examples include a micro-nanoscale surface technology for dental and spine implants, as well as a biodegradable implant for regenerating bone and cartilage.

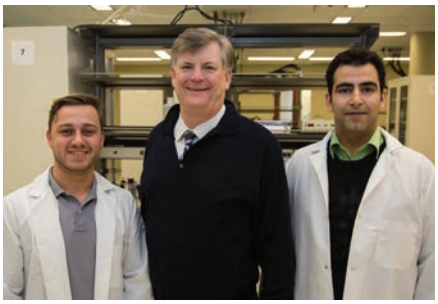


PRESERVING EYESIGHT

Hu Yang, Ph.D., Qimonda Professor in the Department of Chemical and Life Science Engineering, is developing novel medication formulations through nanotechnology that could help glaucoma patients preserve their eyesight. Yang is working on systems to deliver a sustained release of medication so patients would no longer need to use eye drops several times a day. His research is supported by a grant from the National Eye Institute at the National Institutes of Health.

GREEN CHEMISTRY AWARD

B. Frank Gupton, Ph.D., the Floyd D. Gottwald Jr. Chair and chair of the Department of Chemical and Life Science Engineering, and D. Tyler McQuade, Ph.D., professor of chemical engineering, won the 2018 American Chemical Society (ACS) Award for Affordable Green Chemistry. They were cited for their "outstanding success" in developing a sustainable and efficient synthesis of nevirapine, resulting in lowering costs and improving access to HIV/AIDS treatment. The award is sponsored by Dow Chemical.



MENTOR OF THE YEAR

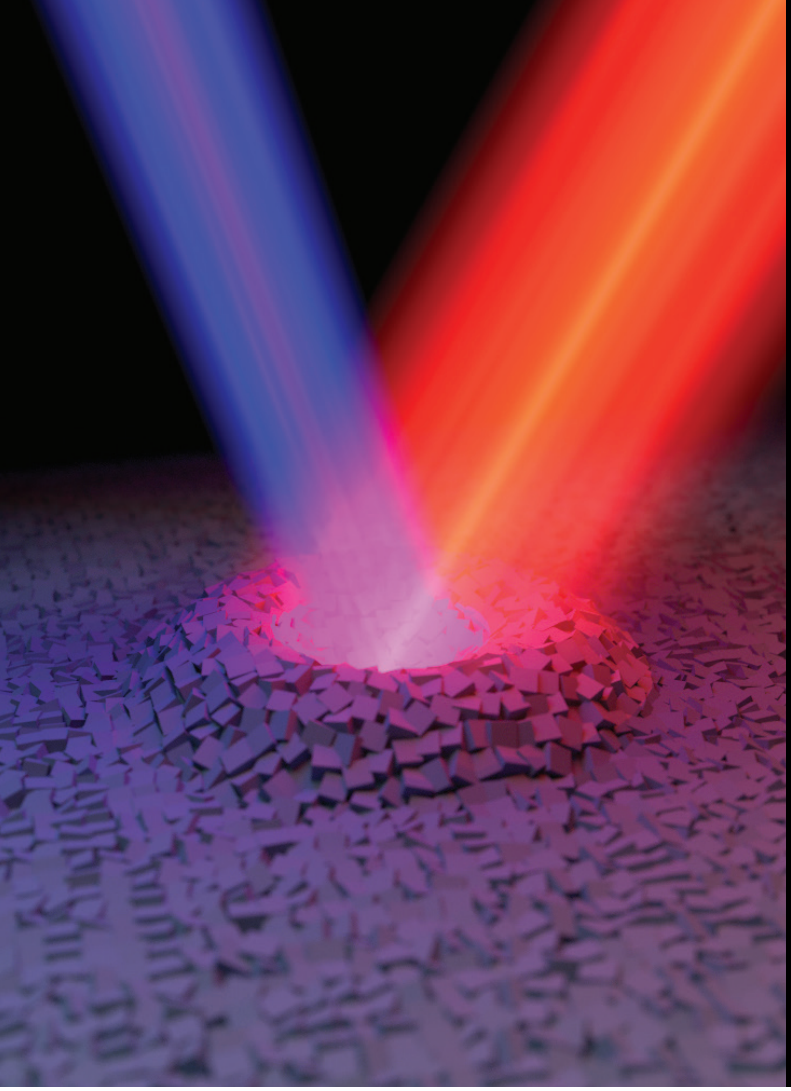
Henry J. Donahue, Ph.D., VCU College of Engineering Foundation Professor and chair of the Department of Biomedical Engineering, received the Orthopaedic Research Society's Outstanding Achievement in Mentoring Award for 2017. The award honors his active promotion of numerous new investigators' scientific and professional development. Donahue is a longtime advocate of convergence research, a paradigm that integrates the content, methodologies and modes of inquiry across diverse disciplines. He said supporting researchers in medicine, biology and engineering has helped bring convergence research to these fields.

MAGNETIC DATA STORAGE

Cloud computing and big data analysis require storing information in ever-smaller spaces. Jayasimha Atulasimha, Ph.D., Qimonda Professor in the Department of Mechanical and Nuclear Engineering, and his team are meeting this need with a magnetic memory technology that dramatically reduces energy consumption and stores information without power. The "up" or "down" polarity of individual magnetic nanostructures can be "flipped" efficiently by applying an electric field. Here the mid-flip is forced through a "skyrmion" state to improve reliability of writing information. His team has also recently explored the implementation of energy efficient neuromorphic (brain-like) computing devices with skyrmions.

ADAPTIVE CYBERLEARNING

Debra Duke, M.S., instructor and undergraduate director in the Department of Computer Science, is principal investigator on a multi-university study to improve student learning in software development and meet growing industry demand for skilled workers in this key area. Strategies include problem-based learning, gamification and social interaction. The team's long-term goal is to provide an adaptive cyberlearning environment that enriches students' conceptual understanding and practical skills. Findings and resources from this three-year, National Science Foundation-sponsored study will be disseminated widely.



ENGINEERING **WITH LIGHT**

With an Air Force Office of Scientific Research Young Investigator Program (AFOSR YIP) grant, Nathaniel Kinsey, Ph.D., assistant professor in the Department of Electrical and Computer Engineering, is conducting research to develop optically enhanced materials. Kinsey is using his award to study how intense light interacts with matter, a discipline called nonlinear optics. Specialty materials with enhanced optical nonlinearities enhance control of the material's refractive index and can improve the design of light-based Wi-Fi, satellite-to-satellite communication systems in space and other devices, allowing them to work much faster. The application of ultraviolet and near-infrared light pulses, for example, creates a prism effect on the doped material. This prismatic effect is the basis of beam steering, which could be used to perform laser ranging similar to what is employed on a self-driving car.

"On the current model, several [light-based radars] do this, and this typically requires mechanical moving parts," Kinsey said. "Our science may lead to a way to bypass some or all of those moving parts, and produce more responsive, robust and low-maintenance systems."

CONFERENCE **LEADERSHIP**

Milos Manic, Ph.D., professor of computer science, will be a general chair of the annual conference of the IEEE Industrial Electronics Society (IECON) Oct. 21-23, 2018, in Washington, D.C. Now in its 44th year, the conference is expected to draw more than 1,000 researchers from around the world.

The conference will focus on industrial and manufacturing theory and applications of electronics, controls, communications, instrumentation and computational intelligence.

Earlier this year, Manic delivered the keynote address at the 2018 International Conference on Information Management and Processing (ICIMP 2018) held at Imperial College London - South Kensington Campus Jan. 12-14, 2018.

Manic's remarks, titled "The Future of Artificial Intelligence — The Age of Trustworthy and Explainable Intelligence," discussed questions of ethics, morality, memory and emotion in AI's "new age." He illustrated aspects of general intelligence and deep learning and provided examples of how to improve trust and provide metrics on confidence in modeling complex control systems.

America's FIRST BREW

A university, a historical foundation and a brewery seem like an unlikely alliance. Unless, that is, you're attempting to recreate America's first beer.

The university? VCU, specifically its College of Engineering and Stephen Fong, Ph.D., associate professor of chemical and life science engineering.

Jamestown Rediscovery Foundation, whose archaeologists continue to excavate Jamestown structures from the 1600s, is the historical component.

Hardywood Park Craft Brewery, a Richmond-based brewhouse that has worked with Fong on other projects and will produce the actual beverage, completes the team.

"It actually makes a lot of sense when you think about it," Fong said of his lab's work with Hardywood. "From a research standpoint, a lot of what my lab does is working with microorganisms (bacteria and yeast). And a lot of the research projects we will do are focused on growing, engineering or modifying them. … So from that standpoint, fermentation and producing alcoholic beverages is essentially what my lab does."

Of course, Fong's lab doesn't routinely create drinkable alcohol. But at the same time, he said, the skill set that his students learn and cultivate on a daily basis is equally transferable to fermentation of beer.

The brewmasters at Hardywood, an international award-winning brewery, were gracious early on, Fong said, letting his chemical engineering students tour its facilities to see the entire fermentation process.

During these tours, Fong and head brewmaster Brian Nelson would often speculate about other ways the university and brewery could work together.

Little did they know they would one day collaborate on reproducing a beer from the Jamestown settlement.

For a number of years the researchers in Jamestown have been studying the lifestyle of early colonists including what they ate and drank. Jamestown archaeologists have identified a structure that they thought could be a brewery, making it the first ever built in the United States. Having worked with the foundation to study the health and food consumption of the colony by looking at the dental material excavated (the earliest remains of Jamestown, dating to the first three years of the colony), Barbara D. Boyan, Ph.D., Alice T. and William H. Goodwin Jr. Dean of the VCU College of Engineering, suggested they contact Fong.

Jamestown, called "America's birthplace," presents archaeology in action for visitors. Rather than being barred from a closed site, visitors can witness ongoing excavations and ask questions of the archaeologists as they work. But the foundation had been looking for something special for the upcoming 400th anniversary in 2019 of the first democratic government in America.

The foundation hoped Fong could analyze fragments for the excavation site to shed some light on details of the early brewery.

Fong, having worked with Hardywood for a while at this point, had an even loftier proposal. How open, he asked, would they be to something more speculative? Would they be willing to allow Fong and his team to prospect for an organism from the site from which they could potentially make a consumable product?

"Not just the analysis part, we'd actually make a product from it," he said. "And they said, 'This sounds awesome!'"

David Givens, senior staff archaeologist of Jamestown Rediscovery, said his team was excited, too.

"Our research has always been predicated on history, science and archaeology, so this is yet another case of an exciting story of early history in Virginia."

The concept was extremely speculative, Fong said. He could run a whole bunch of different tests, and if his luck was really bad — which was often the case, he

said — he could end up with nothing. But chances were good that he would find something.

"The question [becomes] is the something you find actually something that can be used to ferment and make a beverage," he said. "You can find lots of things, but most of them you don't want to drink, whatever it's producing."

Fong and his group, including collaborator Grace Lim-Fong, Ph.D., from Randolph-Macon College, collected samples and returned to Richmond where they started growing their findings in flasks to see if any of them produced ethanol. The second round of sampling last spring resulted in some samples that produced between 5 and 6 percent alcohol by volume (ABV). After testing and retesting, a few of the team members decided to taste it.

"That's all sorts of bad science," Fong said with a laugh. "Using myself as a test subject." But they figured the alcohol content would kill off anything harmful. "It was a 'it smells reasonable, let's just go for it' kind of thing. We all said, 'It's pretty good. It's not bad. We're still alive!'"

As much as possible, the team is using materials that existed in the 1600s, Fong said. In fact, workers are even gathering water from a well dating back to 1608 to add to the brew.

"We'll take the water, analyze it, make sure there are no toxins in it — safety precautions across the board. But at the same time, you could say this is the water from that well." Fong said.

While the team is faithfully recreating every possible component of the 1619 beer, it cannot be 100 percent certain that this was the exact same yeast that they made the beer with in that first brewery that was open in the 1600s, Fong said.

"What we're trying to do is, 'OK, well, this is a pottery shard that we know came from here,'" he said. "If we can get something from that, we can at least make that connection. … Can I guarantee this is what they used? No, but can I say that this is from that period? Pretty much, yes."

Jamestown's Givens noted that the beer is special because it is a collaboration between three organizations with an interest in history, science and archaeology.

"We each do what we do best and will come together to celebrate the beginnings of brewing in America," he said. "If it all works out, folks can literally drink history."

DA VINCI CENTER

The College of Engineering is an integral part of VCU's cross-disciplinary da Vinci Center, which advances university innovation and entrepreneurship for students.

"The engineering talent at VCU is a catalyst for innovation in our region as well as around the world," said Garret Westlake, Ph.D., executive director of the da Vinci Center. "Watching our students pitch international venture capitalists in Italy, win the 2017 Clinton Global Initiative University Codeathon and excel in commercializing U.S. Navy technologies for our partners at the Department of Defense would not be possible without a world class college of engineering."

The center is a collaboration of VCU's schools of the Arts and Business, and colleges of Engineering and Humanities and Sciences. As an academic partner with the prestigious European Innovation Academy, students accepted into da Vinci's Master of Product Innovation degree are admitted to a highly competitive, three-week international accelerator in Turin, Italy. In 2017, Hilton Bennett, who majored in mechanical engineering at VCU, was part of a team whose new business ranked among the academy's top 10 best startups.

Through the da Vinci Center, VCU also joined the Clinton Global Initiative University Network as a partner university, sending a record number of students and alumni to the fall 2017 event.

In the spring of 2018, engineering and other students sought to get dozens of startup ideas off the ground through VCU Pre-X, a pre-accelerator program offering tools, mentorship and funding. Ideas from engineers ranged from 3-D printing discontinued machine parts to innovating air pumps — and even a league for ax-throwing.

STUDENT BRIEFS

AAUW FELLOWSHIP

Maria Molina Higgins, a doctoral student in the Department of Mechanical and Nuclear Engineering, received an American Association of University Women International Fellowship. Recipients are selected for academic achievement and a demonstrated commitment to education of women and girls. The award provides a stipend for Higgins' research in nuclear medicine, which focuses on synthesizing titanium dioxide and gold nanoparticles to improve cancer radiation therapy. Her adviser is Jessika Rojas, Ph.D., assistant professor of nuclear engineering.

NSBE SCHOLARSHIP

Rachel Judge, a senior chemical engineering student, received the National Society of Black Engineers (NSBE) Impact Scholarship at the organization's 2017 annual conference in Kansas City, Missouri. She received one of five awards through the Edward E. Barnette Jr. Community Impact Scholarship Program, which includes a $5,000 scholarship.

Judge is the treasurer of NSBE Region II, which stretches from Pennsylvania to South Carolina. She was president of the NSBE at VCU chapter in 2016-2017.

CYBERSTART SCHOLARSHIP

Computer engineering major Erwin Karincic received a SANS Institute's CyberStart 2017 Scholarship, one of the region's most competitive awards. He placed third among nearly 4,000 students from Virginia and six other states competing in the scholarship challenge. Their progressively more difficult tasks included programming, forensics, cryptography and testing computer systems for security vulnerabilities. The scholarship program aligns with Virginia's workforce goals, which include continuing to build its robust presence in cybersecurity.

PARTNERSHIPS WITH THE U.S.

DEPARTMENT OF DEFENSE

Starting in 2017, the U.S. Department of Defense (DoD) has been partnering with undergraduate student researchers in the college's Department of Electrical and Computer Engineering on projects of interest to the U.S. Army Night Vision and Electronic Sensors Directorate (NVESD). Funding for these projects comes from NVESD's INNOVATIVE DISCOVERY SCIENCE PLATFORM (iDISPLA) initiative, which aims to drive innovation in multiple emerging technologies. The 2017 collaborations were so successful that iDISPLA increased funding for 2018 by 50 percent.

"This ongoing relationship opens doors to opportunities for students to learn about civilian and military engineering careers in the defense industry," said Erdem Topsakal, Ph.D., professor of electrical engineering and chair of the department. The student projects initially grew out of DoD-sponsored faculty research, he said, adding that they support the department's focus on real-world, industry-focused engineering. Here are some highlights:

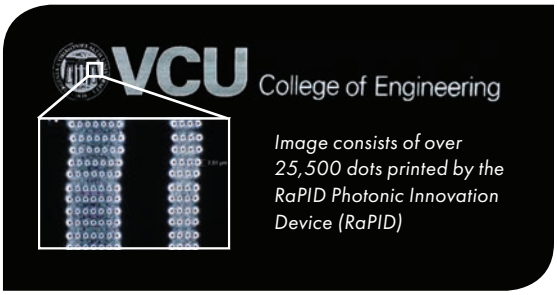


Image consists of over 25,500 dots printed by the RaPID Photonic Innovation Device (RaPID)

VERTICAL TAKEOFF AND LANDING CAPABILITIES FOR AN UNMANNED AIRCRAFT WITH SURVEILLANCE CAMERA SYSTEM

This device allows an unmanned aircraft to maneuver without significant runway space, while the payload chamber gives the camera freedom of movement. A cage protects the payload chamber from wind shear and grasses without compromising image quality.

A RAPID PHOTONIC INNOVATION DEVICE

This device provides a simpler, lower-cost solution for nanofabrication of photonic integrated circuits with applications for fiber optic communications, industrial research environments and makerspace communities. The RaPID system can fabricate photonic features as small as 160 nanometers and does not require a cleanroom environment.

A GESTURE-RECOGNITION ROBOT TO HELP INDIVIDUALS WITH DISABILITIES

This robot uses neural network training technology to capture user-defined gestures and build an expansive library. The robot seeks to help individuals with disabilities perform day-to-day tasks independently. It can also perform movement commands and interface with smart devices when prompted by a specific gesture.

LOW-COST, DURABLE AND EFFICIENT SOLAR CELL POWER SOURCE

This power generation system is based on perovskite cells, named for a crystal structure that absorbs photons and generates electrical energy. These cells are cheaper to produce and have a smaller carbon footprint than silicon solar cells, and can be fabricated on lightweight, flexible substrates.

CCAM FELLOWSHIP

The Commonwealth Center for Advanced Manufacturing (CCAM) is investing in VCU Engineering talent to create processes for transfer to industry and agencies including DoD and NASA. CCAM is an applied research facility in Prince George County, Virginia. Logan Waters, a Ph.D. mechanical engineering student, has a CCAM fellowship for research to optimize electron beam additive manufacturing. His adviser is Ibrahim Guven, Ph.D., assistant professor of mechanical engineering. Electrical engineering doctoral student Arthur French has a CCAM fellowship for research to use acoustic waves in solids to analyze and find defects in 3D-printed parts. His adviser is Erdem Topsakal, Ph.D., professor and chair of the Department of Electrical and Computer Engineering.

LARGE-AREA COLLABORATIVE SURVEILLANCE AND IMAGING

A team of unmanned aerial vehicles (UAVs) with target detection, plus smaller UAVs with live video feed, makes it easier to narrow a search area and locate a victim. The device's ground control station receives images while low-altitude UAVs gather further information to pinpoint the target's location.

WEARABLE TELEMETRY SYSTEMS FOR FIELD OPERATIONS

This washable stretch fabric sleeve monitors military personnel's vital signs in the field including heart rate, sleep cycle, activity and location. The device is less bulky than a Fitbit and its data transmission system is much more secure. Its streamlined printed circuit board can be removed before laundering.

TEACHING CAMERAS TO 'SEE' EXPLOSIVES

Researchers in the Department of Electrical and Computer Engineering are designing a technology to be used in the next generation of explosive-detecting cameras. Principal investigator Erdem Topsakal, Ph.D., along with Vitaly Avrutin, Ph.D., Hadis Morkoç, Ph.D., and Ümit Özgür, Ph.D., are developing a system that detects chemicals used in soft explosives, the simple — often improvised — bombs built from over-the-counter materials. Their technology will respond to chemical's electromagnetic signatures. This project is funded through a $400,000 grant from the U.S. Department of Defense CERDEC NVESD iDISPLA, which supports innovation in multiple emerging technologies.

STUDENT BRIEFS

DOMINION DIVERSITY SCHOLARSHIP

Winners of the Dominion Diversity scholarship work at Dominion Energy in the summer as interns and receive $5,000 scholarships. VCU Engineering's six recipients for 2017 were mechanical engineering majors Brandon Allen, Brooke Clevinger and Julian Lopez; electrical engineering majors Lionel Brookins and Hiba Nabi as well as Rahul Peddi, a nuclear engineering major.

SMART SCHOLARSHIP

Two engineering undergraduates have received the Science, Mathematics, and Research for Transformation (SMART) Scholarship, an award from the U.S. Department of Defense (DoD) that supports the education of the country's top science and engineering students.

As SMART scholars, Jared Snyder, a student in the Department of Mechanical and Nuclear Engineering, and Kevin Yang, a student in the Department of Electrical and Computer Engineering, receive full tuition, room and board, stipends, summer research internships and post-graduation employment with DoD agencies.

NEUP SCHOLARSHIP

Aaron Lam and Nicholus Radcliffe, both seniors in the Department of Mechanical and Nuclear Engineering, received scholarships through the U.S. Department of Energy's Nuclear Energy University Program. This competitive scholarship was awarded to only 58 recipients from universities across the country.

Lam and Radcliffe used their $7,500 awards to study a range of critical nuclear energy issues, including the nuclear fuel cycle and reactor efficiency and design.

URBAN HEAT MAPPING

VCU engineering and arts students teamed up with scientists and community volunteers in July 2017 to find out just how hot it gets in Richmond during a heat wave.

Stephen Fong, Ph.D., associate professor and vice chair of VCU's Department of Chemical and Life Science Engineering, joined Jeremy Hoffman, Ph.D., the climate and earth scientist at the Science Museum of Virginia, to begin developing the first map of Richmond that identifies where large buildings or pockets without any trees or vegetation create "urban heat islands" — areas that can be appreciably hotter than other parts of the city.

Volunteers fanned out in cars and on bicycles across Richmond at three different times on a day when the temperature exceeded 100 degrees. They used highly sensitive electronic thermometers and GPS units to collect data in real time.

Also involved in the project were researchers from Portland State University, Richmond nonprofit group Groundwork RVA and the University of Richmond.

"Specific pockets around the region definitely have elevated temperatures," Fong said, adding that those areas tend not to cool down quickly. "Even when you're sampling later in the evening, you see those elevated temperatures persist."

Urban heat islands can lead to increases in heat-related illness, energy consumption and air pollution. Being able to identify the most vulnerable areas could help officials reduce such impacts and prioritize the allocation of resources. The City of Richmond is using the information to evaluate solutions for the extreme hot spots, Fong said.

As GRTC Transit System installed a Bus Rapid Transit system, Fong said his students were developing inexpensive, self-contained carbon dioxide sensors so researchers can measure both carbon dioxide emissions and temperatures along Richmond downtown's Broad Street corridor. "We would love to monitor that corridor to see what happens before and after the bus system is in place," Fong said.

Photo credit: **Pat Kane**

GREEN WALLS

Commuters and pedestrians at the intersection of Broad and Belvidere streets often gaze up at the gravity-bending Institute for Contemporary Art. Now, those stuck in traffic have something new to admire thanks to the VCU Green Walls Class.

The low-key building shared by VCU RamBikes and the Office of Sustainability has been transformed with vertical planters — commercial, stick built and even made of recycled and adapted materials — in the culmination of a class meshing students from VCUarts and VCU's colleges of Engineering and Humanities and Sciences.

Stephen Fong, Ph.D., associate professor and vice chair in the Department of Chemical and Life Science Engineering, said he began tossing around ideas with Jon-Phillip Sheridan, M.F.A., assistant professor of photography and film, after meeting at a sustainability retreat.

"This idea of the green wall came up as one we both saw as interesting, tangible and meeting immediate needs. It's timely with the global level of CO2," Fong said.

"They definitely have a cooling effect, for the building and the local area," Fong said.

Forty-five students — with roughly equal participation from engineering, arts and biology — enrolled in the class.

Fong, who recently taught a class merging engineering and business students, learned that creating interdisciplinary efforts requires some encouragement.

Each team pursued a different avenue to build and install a green wall. Josh Almeter, a senior mechanical engineering major, said his team decided to compare and contrast nylon fabric vertical planters.

"The purpose of this semester has been to research different ways to compose green walls. We bought a commercial Florafelt wall and we built our own, and we're going to compare them and see how viable it will be to do your own large Florafelt install," he said.

Students embraced the challenges of the Green Walls class — and encourage VCU to break down more walls between schools.

"I spend most of my time with the same students in the engineering college. But here, collaborating with the different majors, it's really nice. It's like a break in my day, a breath of fresh air," Almeter said.

CAPSTONE DESIGN

Two important VCU Engineering programs, Capstone Design and Vertically Integrated Projects (VIP), immerse engineering students in the processes of solving real-world problems. With exciting new partnerships, these programs are becoming more interdisciplinary and entrepreneurial than ever.

> "VCU'S ENGINEERING GRADUATES HAVE EXCELLENT TECHNICAL KNOWLEDGE AND ARE GROUNDED WITH A SENSE OF BUSINESS. THEY'RE BROADER IN THEIR UNDERSTANDING OF THE WORLD. OUR MOST SUCCESSFUL EMPLOYEES COME FROM VCU, AND WE'RE EXCITED TO HAVE A STRATEGIC PARTNERSHIP."
>
> **Jim Yu**
> RetailData Inc.

START ME UP

Capstone Design is the culmination of every undergraduate student's engineering education. The Capstone process begins with real problems posed by sponsoring organizations or businesses. Longtime Capstone partners include Altria, AREVA, Capital One and Dominion Energy. Capstone students form teams and, for eight or nine months, prototype a solution to one of the problems. In April, they unveil their prototypes at the Capstone Expo, a major community event that draws more than 1,000 visitors to the VCU Siegel Center for a glimpse of tomorrow's technologies.

Now those visitors may be getting a preview of the next hot new company, too, thanks to a program that teaches engineering and business students how to create a startup. The two-semester entrepreneurship capstone course, New Venture Strategy and Initiation, gives students a cross-disciplinary learning experience that results in innovative products — and viable platforms for getting them to consumers.

The program has been an incubator for commercializing inventions that include a wearable heart monitor that automatically calls 911, a heating and cooling backpack and a fog harvesting surface that can supply water in arid climates.

"At VCU, our motto is 'Make it real,' and this partnership does that by creating a mechanism for students to take products to market," said Bennett C. Ward, Ph.D., director of project outreach and Capstone Design coordinator. "In real life, business and engineering do this by working together. Innovation and commercialization is never one person working alone."

Translation is key to successful innovation, according to Ward and Susan Coombes, Ph.D., associate professor of management and entrepreneurship Capstone course instructor. The two groups don't always speak the same language, so "user experience," for example, can mean one thing to businesspeople and something else to engineers. "We'll hear, 'This product is really easy to use' — but if it's only easy for engineers, it has to change," she said. "We push them to develop as much understanding of the other side as possible."

The Sternheimer Awards also nurture innovative, entrepreneurial Capstone

projects. Established in 2012 by major benefactor and Foundation Board member Mark A. Sternheimer, the Sternheimer Awards give Capstone teams a chance to pitch their projects to a panel of judges from Richmond-area companies. Winners of these highly competitive awards receive valuable exposure and additional funding for their projects. This year's Sternheimer Award winners include a smart birdhouse that gathers data for conservation efforts as well as a safer (and greener) refrigeration system based on magnetic cooling technology instead of conventional compressors.

Another Sternheimer Award winning team designed a novel isolette for premature infants that controls light stimuli and also allows close monitoring. The team was one of six in the U.S. selected to present their invention at the National Academy of Inventors meeting in April, 2018.

TAKE IT TO THE NEXT LEVEL

VCU Engineering's Vertically Integrated Projects (VIP) program means early undergrads don't have to wait to roll up their sleeves and start innovating on a large scale.

VIP@VCU puts undergraduate engineering students on teams with graduate students and faculty to work on multi-year, interdisciplinary projects. Undergraduate VIP students earn academic credit and take on leadership roles as they advance through the program. In 2015, VCU joined the prestigious VIP Consortium, which includes engineering programs at the Georgia Institute of Technology, Rice University and the University of Michigan. VCU Engineering remains Virginia's only member of the consortium.

Now, VIP projects are also being showcased at the Capstone Expo. VIP highlights at the 2018 Expo include new technologies for multiple unmanned aerial vehicle (UAV) collaborative teams as well as a smart data device for bone marrow transplant patients and for newborns in intensive care.

Capstone Expo visitors also got to see Hyperloop at VCU, a VIP team designing and building a transportation pod for SpaceX's 2018 Hyperloop Pod Competition. They are part of an elite group of 20 teams selected internationally to advance to the competition's final round.

RAPID NICOTINE TEST FOR E-CIGARETTES

VCU students are designing tools that law enforcement officials could someday use to quickly detect nicotine in e-cigarettes being sold illegally to minors.

A multidisciplinary team of students from the departments of Chemical and Life Science Engineering and Biomedical Engineering developed two approaches to test for nicotine in e-liquids for its Capstone Design project in 2016-2017.

In one approach, the group found that nicotine in an e-liquid could quickly be discovered when using test strips and a dye that changes color in the presence of the substance. The team also developed a concept to use an ultraviolet/visible spectrophotometer to detect the substance.

Four other chemical and life science engineering students, along with two entrepreneurship students from the VCU School of Business, are moving the project forward by further developing the concepts and business plan.

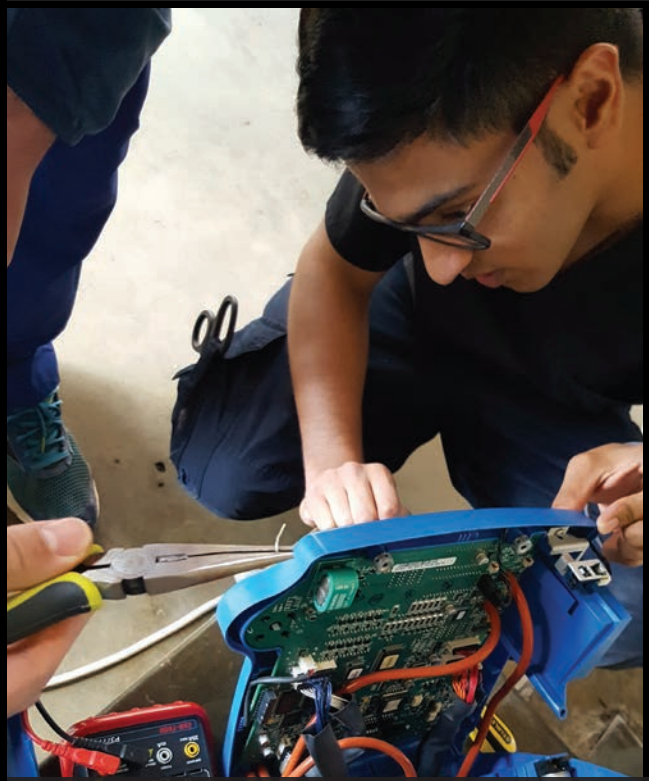
This year's team developed a plan to add nicotine to the list of substances that a handheld Raman spectroscopy device could test for using infrared light.

VCU ENGINEERING

Chemical and life science engineering Ph.D. student **Lynn Secondo** studied for nine months in Thermi, Greece, on a Fulbright scholarship. Her research focused on nanoparticles that come from diesel exhaust and how they affect the lungs.

Corey Sutphin, a computer science major, spent a semester in 2017-2018 studying artificial intelligence at Heriot-Watt University in Edinburgh, Scotland, in the U.K.

Stuck in a lab or a classroom? Not these VCU Engineering students and alumni. Through the VCU Global Education Office, engineering faculty members taught courses on nuclear reactor physics in Dresden, Germany, and robotics in Barcelona, Spain. The Engineering World Health (EWH) student organization led trips to Tanzania and Nicaragua. Meanwhile, other students pursue their own research and individual interests through Fulbright and other scholarships.



Biomedical engineering major **Nilan Vaghjiani** was among VCU students working in Tanzania for a month in the summer of 2017 through the Engineering for World Health organization, repairing hospital equipment and training hospital staff to improve quality of and access to healthcare.

Computer science major **Abigail Byram** studied Mandarin for eight weeks in the summer of 2017 in Dalian, China, on a Critical Language Scholarship.

AROUND THE GLOBE

In 2017, six undergraduate and graduate mechanical and nuclear engineering students took a course on reactor physics at the Technical University of Dresden, in Dresden, Germany. The group was led by **Sama Bilbao y León, Ph.D.**, associate professor and director of nuclear engineering programs. On the trip were graduate students **Taylor Britt** and **Cody Lloyd**, and undergraduate students **Ben Brandt, Ivan Cano, Jake Littlepage** and **Abhishek Nigam**.

Mechanical and nuclear engineering alum **Hilton Bennett** *(left)* competed at the prestigious European Innovation Academy in Turin, Italy, in July 2017, through the Master of Product Innovation degree program at VCU's da Vinci Center. His team's startup, focused on quickly testing seafood for dangerous toxic metals, ranked among the academy's top 10 best startups.

Ravi Hadimani, Ph.D., assistant professor in the Department of Mechanical and Nuclear Engineering, joined students **Henry Garcia** and **Sierra Semel** as they studied magnetics at Cardiff University in Wales, U.K., in the summer of 2017.

Electrical engineering student **Roxanne Jassawalla** got to travel to Barcelona as part of a robotics study abroad program in July 2017.

Photo credit: **Garrett Blackwell**, faculty, VCUarts

ABROAD IN **CUBA**

> IN SOME WAYS IT IS LIKE BECOMING MACGYVER — IMPROVISING SOLUTIONS IN SEEMINGLY IMPOSSIBLE CIRCUMSTANCES.
>
> *Russell D. Jamison, Ph.D.*

Imagine finding yourself 1,000 miles away on an island — where you may not speak the local language — with only hours to identify and to solve a design problem. You are teamed up with people not trained in your field and you're restricted to one material: bamboo.

That's the experience that 15 VCU engineering and arts students found themselves immersed in during the university's first Designing Cuba intensive study abroad workshop in May 2017. The course was the brainchild of Russell D. Jamison, Ph.D., Alice T. and William H. Goodwin Jr. Chair of Engineering Education, professor in the departments of Biomedical Engineering and Chemical and Life Science Engineering and dean emeritus of the VCU College of Engineering. The students explored the concept of design within constraint — using bamboo as an example and newly reopened Cuba as the environment.

Sara Reed, Ph.D., an adjunct professor of interior design at the VCU School of the Arts, led the program. She said examples of ingenuity and creating within constraint abounded at the bamboo workshop that hosted the students.

Jamison said, "We look at the empowering force of constraint on design thinking. In some ways it is like becoming MacGyver — improvising solutions in seemingly impossible circumstances. You're in a locked concrete cell with nothing but a coat hanger and roll of duct tape. Once the initial panic and hopelessness subsides, it is remarkable how quickly creative solutions begin to form. Constraint frees the mind to innovate."

DEAN'S UNDERGRADUATE RESEARCH INITIATIVE

Biomedical engineering senior Alexandria Ritchie took top honors at the 2017 Dean's Undergraduate Research Initiative (DURI) Symposium. She received first place for a study using nanoparticles to regenerate lung tissue. Ritchie's research took place in the laboratory of Rebecca Heise, Ph.D., associate professor in the Department of Biomedical Engineering. Her mentor was biomedical engineering doctoral candidate Patrick A. Link. DURI gives undergraduates a long-term, immersive research experience alongside faculty, graduate student and postdoctoral fellow mentors. It also gives graduate students and postdoctoral fellows the opportunity to develop managerial and mentorship skills.

DEAN'S EARLY RESEARCH INITIATIVE

The Dean's Early Research Initiative (DERI) brings high-achieving high school students into VCU labs and lets them dig into yearlong, real-world engineering research projects alongside grad student and faculty mentors. The program continues to grow in popularity and impact. With 19 DERI fellows,the 2016-17 cohort was the largest to date.

The 2017-18 cohort was bigger still, with 30 DERI fellows. One fellow, Phillip Daire, shown above, worked on a project to help stabilize unwanted bone growth within a marrow cavity. The honors chemistry and math student said, "You hear about lots of high school science opportunities, but DERI is different — it's real." Daire's mentor was D. Joshua Cohen, M.D., assistant professor in the Department of Biomedical Engineering.

STUDENT BRIEFS

3MT CONTEST

The challenge behind the Three Minute Thesis (3MT®) contest is simple: explain your research effectively in three minutes. The second annual event for VCU Engineering graduate students was held April 13, 2018.

2018 WINNERS

1st: Otto Juhl, biomedical engineering
2nd: Maria Molina Higgins, mechanical and nuclear engineering
People's Choice: Hamidreza Sadeghian, electrical and computer engineering

2017 WINNERS

1st & People's Choice: Kelly Hotchkiss, biomedical engineering
2nd: Joseph Nalluri, computer science

PARTNERSHIP WITH VMI

VCU Engineering and the Virginia Military Institute (VMI) are partnering to bring some of the Institute's rising seniors to VCU for research in VCU's Department of Mechanical and Nuclear Engineering. Lexington-based VMI offers engineering through the undergraduate level. The program gives top VMI students the opportunity to participate in graduate-level research. It also exposes these students to VCU's graduate programs, including its hybrid doctorate in mechanical and nuclear engineering, the only one in the U.S.

CGI U

Biomedical engineering student Mashaba Rashid was among the largest contingent of VCU students and alumni accepted to participate in the 2017 Clinton Global Initiative University (CGI U) in October 2017. The prestigious event brought together more than 1,100 innovative students from around the world who are committed to tackling some of today's most pressing challenges. Rashid, who launched an environmental education organization in high school, returned from the event at Northeastern University inspired to make a difference.

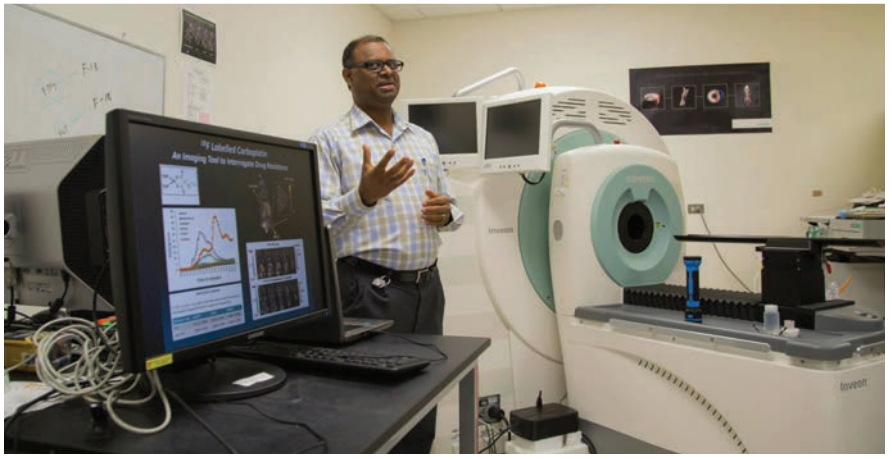
K-5 TEACHER WORKSHOP

Hanover County elementary school teachers learned how everyday items can help teach STEM at a VCU Engineering pilot workshop in July 2017. Participants saw how a glass of water topped with shaving cream and food coloring can model the water cycle, and how a salad spinner and paint can colorfully demonstrate Newton's Law of Motion. Educators left with more than 25 classroom projects that can be done with simple, inexpensive supplies.

INNOVATION DAYS

Faculty and students from VCU Engineering presented four Innovation Days at local elementary schools featuring hands-on STEM experiences that address Virginia Standards of Learning objectives in math and science for grades four and five. Activities included building with marshmallows, coding robots, launching rockets, constructing prosthetic hands and magnetic painting. More Innovation Days are coming up!

COMMUNITY **OUTREACH**



GUIDE RUNNING

As a guide runner, electrical engineering doctoral student Freddy Derenthal helps runners who are visually impaired by running alongside them when they train or compete. "It has opened my eyes to accessibility — really 'inaccessibility' — issues people with disabilities are tasked with," he said. "I'd love to see engineers take an expensive gadget for athletes with disabilities and make it cost-effective," he said.

NUCLEAR SCIENCE TEACHER WORKSHOP

K-12 educators gained a deeper understanding of nuclear science thanks to the Science of Nuclear Energy and Radiation workshop at VCU Engineering in July 2017. Classroom, laboratory and field trip experiences gave teachers up-to-date information from nuclear science researchers and industry professionals. Topics included nuclear energy and technology, nuclear power plant basics and safety, use of Geiger-Müller counters, biological effects and medical uses of radiation.

LSAMP

VCU's Louis Stokes Alliance for Minority Participation (LSAMP) is an NSF-funded program committed to enriching all of the STEM fields with talent from traditionally underrepresented groups. LSAMP's Summer Transition Program brings participating first-year engineering students to campus a week before the start of classes for guest lectures, workshops, research experiences and team building to enrich the high-school-to-college transition process.

Ram engineers don't just build better technologies and devices — they build stronger communities. VCU Engineering faculty, students and staff are reaching out to educators with ideas and resources that transform classrooms into learning laboratories. They're also giving K-12 students a first-hand look at the wonders of engineering, enriching the future of the field by promoting diversity and lending a helping hand where it's needed.

3D ENGINEERING

Learning about science and technology took on a completely new dimension at 3D Engineering, a 2017 VCU Summer Discovery Class hosted by the College of Engineering's MNE Innovation lab. The course allowed 17 future engineers and STEM leaders (sixth to eighth grade) to let their creativity run wild as they learned the fundamentals of engineering, applied them to their own mechanical designs and 3D printed the results.

1,968

K-12 STUDENTS REACHED THROUGH COMMUNITY ACTIVITIES SINCE JULY 2017

24

COMMUNITY-DRIVEN ENGINEERING STUDENT ORGANIZATIONS

140

STUDENT, FACULTY & STAFF VOLUNTEER ENGAGEMENTS SINCE JULY 2017

EarthHacks

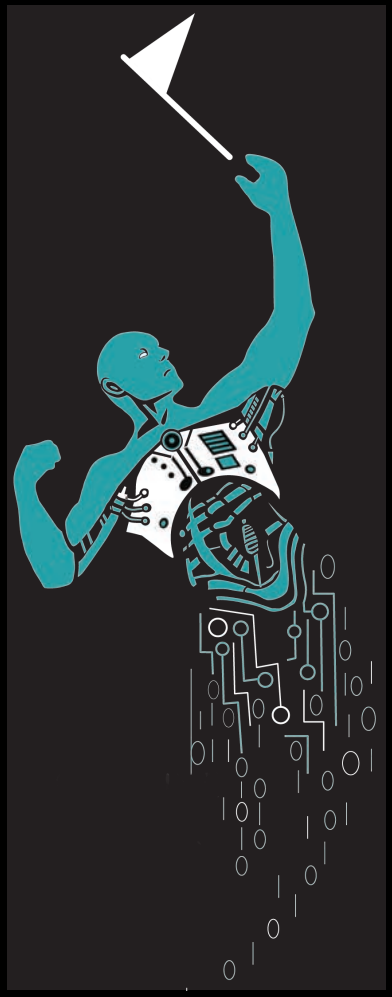
DEPARTMENT OF CHEMICAL & LIFE SCIENCE ENGINEERING

In less than 24 hours, 15 teams of VCU and other college students developed solutions to solve real-world environmental challenges at the university's first EarthHacks. The innovation-focused competition, conceived and organized by VCU Engineering's Department of Chemical and Life Science Engineering, was held at the Science Museum of Virginia March 17-18, 2018. The next EarthHacks will take place Jan. 26-27, 2019.

DEPARTMENT OF MECHANICAL & NUCLEAR ENGINEERING

power the future 2018

VCU's Department of Mechanical and Nuclear Engineering is partnering with Dominion Energy to present Power the Future at VCU October 20-21, 2018. In this 24-hour challenge, college students from all disciplines will be briefed on a Dominion Energy-related scenario. Teams will brainstorm, prototype and present their innovative solutions to a panel of industry experts. The top three teams will receive cash prizes. Dominion Energy internships may be offered to select participants.



DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

M2M

MACHINE TO MACHINE
CAPTURE THE FLAG

Machine-to-Machine (M2M) is a multi-focus daylong hacking competition — capture the flag/jeopardy-style — that tests competitors' cyber- and cyber-physical security skills in a variety of machine-to-machine challenges. Student teams converged at East Hall April 21, 2018. There they tested their knowledge of application security, network security, digital logic and circuits in a marathon of challenges of varying difficulty. The event was organized by the Department of Electrical and Computer Engineering.

DEPARTMENT OF BIOMEDICAL ENGINEERING

HEALTH HACKS

Health care innovators and students from multiple universities and disciplines gathered Nov. 4-5, 2017 at VCU Engineering for the second annual HealthHacks, VCU's medical hackathon. Pediatric and global health issues were the focus of the intense problem-solving and prototyping event.

HealthHacks began with real problems and unmet medical needs pitched by medical stakeholders. More than 100 students from seven universities took on those challenges and, 24 caffeine-fueled hours later, teams presented 29 working prototypes to a panel of judges.

Solution prototypes took many forms including Solidworks® CAD concepts, 3D-printed designs, new health care smartphone apps, computer programs or designs improvements on existing medical devices. VCU physicians, faculty and staff, along with industry professionals from fields including medical device manufacturing and product design, were on hand to give technical guidance and help troubleshooting concepts.

After two rounds of presentations, the judges declared the winners. Coming in first place was Solace, a mobile app for teens diagnosed with chronic illnesses to connect with each other and promote emotional resilience.

In second place was AVM (Adjustable Vitals Monitor), a vital signs monitor that senses and records SpO2, heart rate, blood pressure and temperature of an individual from their wrist or ankle, and can be moved to upper arm or leg.

Grow with It PVChair came in third place, for a width-adjustable children's wheelchair made from materials that can be accessed in developing countries including PVC, bicycle wheels and shopping cart wheels.

The next HealthHacks is set for Nov. 3 and 4, 2018, at VCU.

RAM HACKS

DEPARTMENT OF COMPUTER SCIENCE

The 2017 RamHacks drew more than 200 participants from schools in the Richmond region — as well as Florida and California. Nearly 40 teams vied for more than $8,000 in prizes at VCU's fourth annual RamHacks hackathon Sept. 16-18, 2017. Students optimized flight simulators, paired facial recognition with artificial intelligence and created chatbots — all in 24 hours.

At RamHacks, student teams collaboratively design and implement software and/or hardware applications of their choice. RamHacks is open to any university student, so this event brings together those with serious coding skills, as well as programming newbies. Teams work collaboratively to design and implement a software and/or hardware application in this no-creative-boundaries competition.

First place went to Good Pill Hunting, an intuitive and interactive app that helps users monitor their medications. Features include facial recognition, support from Amazon's Alexa and an easy-to-work-with user interface that works with cellular devices.

Second place went to Automated Orbital Rendezvous, which can help NASA and the commercial space industry calculate distance to target and streamline maneuver planning. The team also developed a plan to integrate their prototype with a newly released simulator from NASA.

Octobot, which employs user interface to send values to the Amazon Lex API to programmatically create a chatbot, took third place. The interface's intents, a web-scraping function written in Node. JS, parse a webpage for FAQ questions and answers.

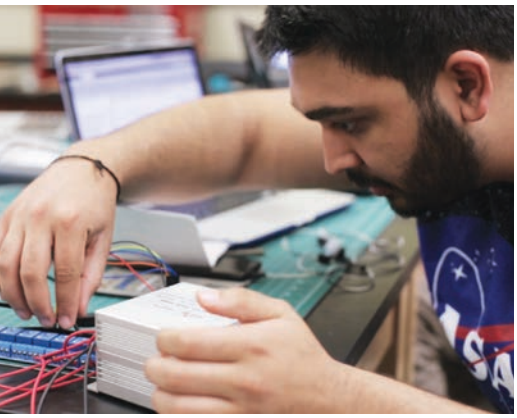
The next RamHacks will take place at VCU on Sept. 22-23, 2018.

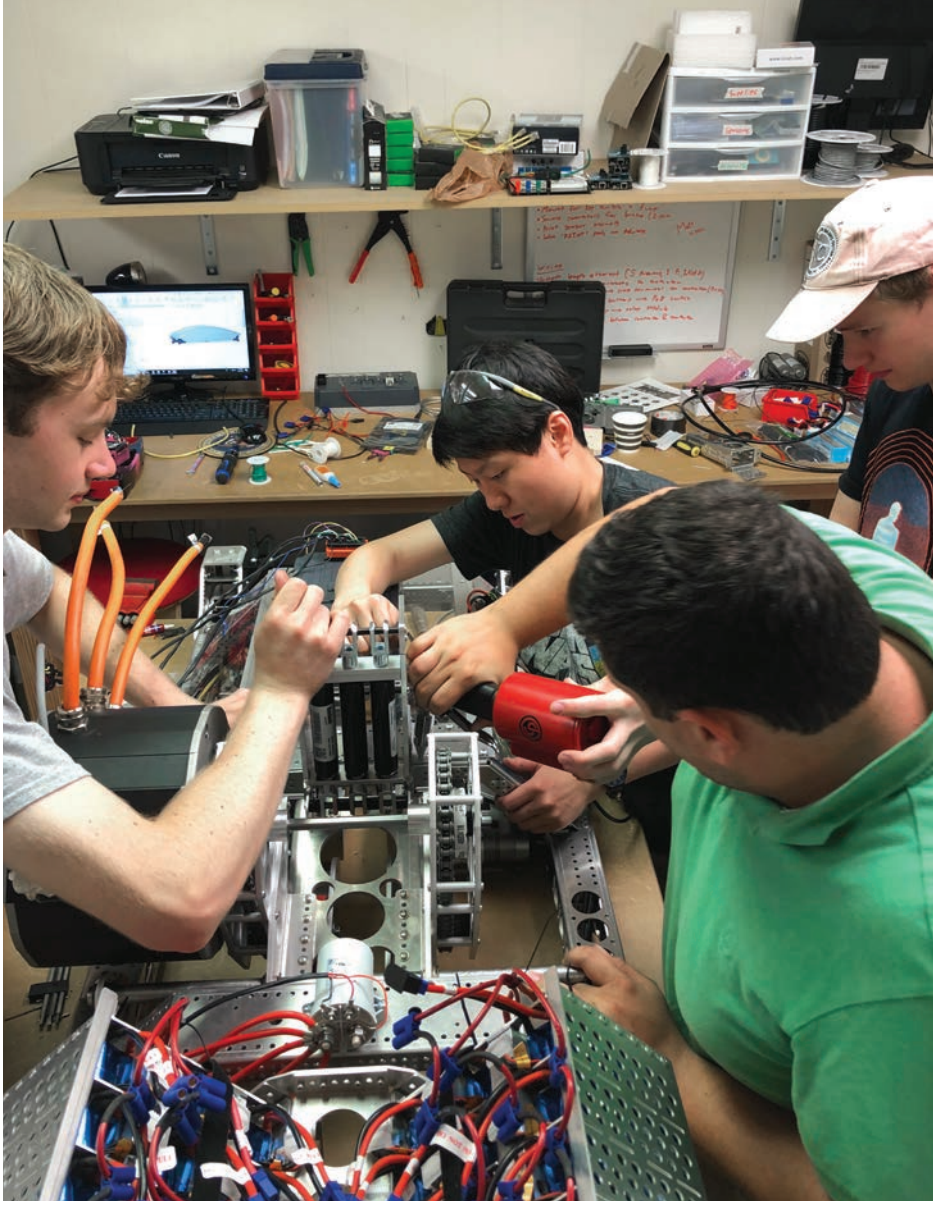
DARKENING ISOLETTE WALLS

A team of biomedical engineering seniors was one of just six in the nation chosen to present at the National Academy of Inventors (NAI) 2018 Student Innovation Showcase. Aniket Kulkarni, Chandana Muktipaty, Joshna Seelam and Kashyap Venuthurupalli designed a light-controlled isolette, or incubator, for premature infants.

Currently, hospital staff often cover isolettes with blankets to limit light and help infants sleep. This practice hinders monitoring of the infant, poses infection risk and can create an environment that is too dark for infant development. To address these issues, the team developed a novel adaptive kit that allows neonatal staff to control the opacity of isolette walls from clear to opaque in order to create a restful environment for the infant and provide visual monitoring and other safety features.

They have formed a company and are commercializing their invention, which is called the Brise-solette. The name comes from the French term "brise soleil" ("sunbreaker"), which describes an architectural awning.





HYPERLOOP AT VIRGINIA COMMONWEALTH UNIVERSITY

VCU's new student Hyperloop team was one of only 20 teams in the world to earn a coveted spot in the final round of SpaceX's Hyperloop Pod Competition. Hyperloop at VCU, which formed in the fall of 2017, includes more than 35 active students from the departments of Mechanical and Nuclear Engineering, Electrical and Computer Engineering and Computer Science as well as business, arts and humanities and sciences students. A VCU Engineering VIP team is leading the initiative.

The competition challenges university teams to design and build the best transport pod for Hyperloop, the concept of high-speed ground transport being advanced by SpaceX founder Elon Musk.

"I can see Hyperloop becoming the transportation of the 21st century and I wanted to be a part of making that happen," said Arthur Chadwick, a rising junior mechanical engineering student and founder and president of Hyperloop at VCU.

ROCKET WAGON

Alumni Luke Libraro and Skylar Roebuck first crossed paths as computer engineering students a decade ago. Together, they went on to launch HackRVA — one of Richmond's longest-running makerspaces — and teamed up at several other startups. Most recently, they cofounded Rocket Wagon, an Internet of Things consultancy firm based in Chicago.

Rocket Wagon's focus, IoT, is red-hot. Through the addition of sensors to objects, "we create new data, opportunities and experiences that allow us to completely re-imagine businesses and unlock opportunities for our clients," said Roebuck, the chief digital officer. Libraro, the company's chief technology officer, said, "By making everyday objects 'smart' and connecting them to the internet, IoT is making people's lives easier and their businesses more agile in very significant ways."

Rocket Wagon works with companies to develop cutting-edge strategies to take advantage of the power of connected devices. The firm also provides end-to-end delivery of the IoT solutions they dream up. The company boasts a high-profile board and is rapidly growing. They're even considering opening an office back in Richmond.

BRAD TREVILLIAN

Brad Trevillian (B.S. '06), director of Trane Supply, leads the air conditioning giant's global aftermarket business. He said VCU's mechanical engineering program set his path for leadership with Trane. "My career started at VCU, literally," Trevillian said. "Between my junior and senior years, I created an internship for myself at Trane, and I've been there ever since." He returned to Trane's Richmond office as a sales engineer after graduation and quickly stood out as a top performer. He and other employers are eager to hire Ram engineers because they "bring a sense of the real world with them," Trevillian said, adding that their work ethic, maturity and business savvy set them apart. "I think they have more emotional intelligence, too, because of the diversity of backgrounds and disciplines they're exposed to at VCU."

FAHAD HARHARA

Fahad Saif Harhara, Ph.D., (B.S. ’00) is chief programs officer for the Tawazun Economic Council, a government project launched in 1992 to diversify the UAE economy and increase domestic production. Previously, he was CEO of Abu Dhabi-based NIMR Automotive, the leading manufacturer of military vehicles in the Middle East and North Africa. Harhara was a member of the college’s first class. “It was a career risk taken by both the students and the college,” he said. “Twenty-two years later, the successful outcome of that risk speaks volumes.”

Rhonda Cosentino photography

ISAAC RODRIGUEZ

Isaac Rodriguez, Ph.D. (M.S. ’10 / Ph.D. ’13), received a VCU Alumni 10 Under 10 award. Rodriguez, who holds two biomedical engineering degrees from the VCU College of Engineering, co-founded the biotech company SweetBio in Memphis, Tennessee, in 2015. SweetBio is developing a regeneration membrane for oral surgeries that uses medical-grade honey.

KELLI MCKENNA

Kelli McKenna (B.S. ’16) interned with Altria while completing her degree in mechanical engineering and went to work with the company full time upon graduation. As an engineer in Altria’s Center for Research and Technology, McKenna spearheads novel e-vapor device development. She also provides mechanical design and data analytic support for other innovative product concepts.

> WE WATCHED THE SCHOOL OF ENGINEERING GROW. WE SAW WHAT IT LOOKS LIKE WHEN SOMETHING IS BEING BUILT, SO DOING THAT FOR THE COMPANY WAS NOT THAT DIFFERENT.
>
> *Julia Cain*

ALUMNI SCHOLARSHIP

Julia (B.S. '01) and Nicholas Cain (B.S. '01), two VCU College of Engineering alumni who helped to build one of the nation's most influential craft brewing businesses, have established a scholarship for chemical engineering undergraduates. The Julia and Nicholas Cain Scholarship is the college's first scholarship endowed by VCU Engineering alumni.

The Cains are part of the leadership team that worked to scale San Diego, California-based Ballast Point Brewery into an internationally recognized craft beer brand.

When Ballast Point was sold for $1 billion, the time was right to create a new scholarship for the program where they met and their professional journey began. VCU's engineering program was a year old, and there was a sense that "something new and exciting was being created here," according to Nick. They said witnessing the birth of a new engineering college yielded important lessons. "We watched the School of Engineering grow," said Julia, who now serves on the VCU College of Engineering Foundation Board of Trustees. "We saw what it looks like when something is being built, so doing that for the company was not that different."

All first-year engineering students resided on two floors of Rhoads Hall when the Cains were undergraduates, which Julia Cain said helped the burgeoning program build a culture and a sense of community. Her husband agreed. "It's important to remember that West Hall wasn't here then," he said. "Engineering classes were all over campus, so it was important that engineering students could reside together."

Both said the training they received under superb, demanding faculty members such as Gary Huvard, Ph.D., former associate professor of chemical engineering, and Gary Wnek, Ph.D., former chair of the Department of Chemical Engineering, imparted many of the creative thinking and problem-solving skills that fueled their careers.

Their advice to the VCU chemical engineers who will benefit from the Julia and Nicholas Cain Scholarship? "Go out and find problems to solve," he said. "Follow your passion and don't be afraid to take a risk."

CHASE GRECO

Computer science alum Chase Greco (B.S. '17 / M.S. '18) recently joined real estate analytics giant CoStar Group, the leading provider of commercial real estate information and online marketplaces. CoStar selected Richmond as its headquarters for operations and global research in 2016. Greco initially connected with the company at that time, through VCU's Capstone Design Expo. As organizer of VCU's RamHacks, Greco crossed paths with CoStar again. "I got my job offer in November 2017 after meeting with CoStar's senior VP of product development at RamHacks," Greco said. As a software engineer Greco will spearhead a new machine learning initiative within the company. "My graduate studies gave me the foundation in machine learning to qualify me for such a position," he said.

OFFICE OF THE DEAN

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Research Topics:
- Tissue engineering
- Response of cells to biomaterials
- Mechanisms of action of hormones and growth factors in chondrocytes and osteoblasts

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- Student experiential learning and makerspaces
- Regulatory pathways for medical devices

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- Signal processing
- Medical devices

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- Batteries and supercapacitors
- Nanoparticles and smart medicine

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- Cyber-physical systems security
- Hardware/software codesign

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- Traffic and transportation engineering
- Institutional research, strategy and policy

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- Database design
- Handling missing information in databases

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- Electron microscopy for archaeological applications
- Chemical and biological miniature sensors

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Research Topics:
- Regulation of bone and cartilage
- Implant and bone substitute mechanism of action and clinical use
- Steroid hormone mechanism of action in health and cancer

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- Smooth muscle biomechanics
- Robotic devices for medical applications
- Bladder biomechanics and urodynamics

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- Molecular interactions
- Computational intelligence

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- Capstone design processes
- Medical device development
- High performance polymers and fibers

BIOMEDICAL Engineering

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Research Topics:
- Musculoskeletal tissue engineering and regenerative medicine
- Musculoskeletal adaptation to spaceflight
- Mechanobiology

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Research Topics:
- Breast cancer metastasis to bone
- Orthopedic and dental implantology
- Small animal model surgery

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Research Topics:
- Mechanotransduction
- Live-cell imaging
- Cellular biomechanics

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Research Topics:
- Sensor network-based lower-limb prosthesis optimization and control
- Bioinstrumentation and telemedicine devices
- Technologies for radiation oncology

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Research Topics:
- Lung injury
- Pulmonary regenerative medicine
- Mechanobiology

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- Innovation and entrepreneurship
- Leadership of teams in ambiguity
- Design for highly-constrained environments

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- Mechanobiology in the extracellular matrix
- Biomechanics of fibrosis
- Cellular contractile force measurements

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Research Topics:
- Skeletal muscle
- Regenerative medicine
- Stem cells

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Research Topics:
- Artificial hearts design and evaluation
- Speech recognition for distorted speech and noisy environments
- Design of assistive technology

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- Cell instructive materials for stem and immune cells
- Immunomodulation in regeneration
- Craniofacial and orthopedic tissue engineering and regenerative medicine

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Research Topics:
- Assistive technology for individuals who are blind or visually impaired
- Improved situation awareness and skills training
- Hand prostheses

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- Assistive technology for elderly patients and caregivers
- Image segmentation in medical applications
- Ultrasound techniques for studies of pressure ulcer progression

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- Neurorehabilitation to improve sensorimotor function
- Modeling and simulation of human movement
- Musculoskeletal dynamics

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- Meniscus, tendon and ligament tissue engineering and regeneration
- Collagen fiber development
- Musculoskeletal mechanobiology

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- Medical imaging physics
- Clinical translation of new MRI technologies
- Development of imaging-based diagnostic tools in Traumatic Brain Injury

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Research Topics:
- Experimental and computational simulation of musculoskeletal function
- Mechanical evaluation of structures
- Morphologic analysis of 3D biological structures

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Research Topics:
- Computational modeling of physiology and disease
- Cardiac electrophysiology and mechanisms of arrhythmias
- Mechanobiology and extracellular matrix assembly

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Research Topics:
- Eye tracking systems and eye movement analysis
- Effects of neurological diseases on eye movement control
- Visual task analysis

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Research Topics:
- Stem cell biology and clinical translation
- Central nervous system trauma and diseases
- Biomaterials for oral biofilm prevention

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Research Topics:
- Bone biology and regeneration
- Cartilage biology
- Animal models of musculoskeletal conditions

CHEMICAL & LIFE SCIENCE Engineering

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- Cross-coupling catalysis
- Flow chemistry/continuous chemical processing
- Organic synthesis in pharmaceutical applications

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Research Topics:
- Process development
- Pharmaceutical APIs
- Continuous synthesis

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Research Topics:
- Soft matter principles applied to (bio) pharmaceuticals manufacturing
- Design and applications of emulsions
- Colloids and interfacial phenomena

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- Organic synthesis applied to API manufacturing
- Biocatalysis
- Medicinal chemistry

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Research Topics:
- Continuous flow chemistry/ continuous manufacturing
- High throughput chemistry and automation
- Convergent organic synthesis of molecules of medicinal value

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Research Topics:
- Interfacial phenomena
- Stability in disperse systems
- Additive manufacturing

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Research Topics:
- Metabolic engineering
- Computational metabolic modeling
- Biorefineries

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- (Bio)pharmaceutical crystallization
- Chemical engineering

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- Laboratory safety
- Capstone design projects

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- Biological effects of nanoparticles
- Advanced in vitro exposure systems
- Nanomedicine

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- Polymer solution phase behavior at high pressures
- High pressure thermophysical properties of hydrocarbons, fuels and lubricants

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- Small molecule synthesis
- Chemist-machine partnerships
- Molecular engineering

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- Protein engineering: protein interactions and misfolded protein states in disease
- Nanolipid drug carriers
- Nonequilibrium statistical mechanics

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Research Topics:
- Continuous flow chemistry and reaction engineering
- Biocatalysis and metabolic engineering of reaction pathways
- Particle sciences and formulation engineering

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Research Topics:
- Smart, multifunctional textiles/ polymer composites
- Self-assembly of metal-polymer hybrid nanoparticles
- Rheology of polymers/gels/biopolymers

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Research Topics:
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- Stem cell biology and engineering, tissue engineering and regenerative medicine
- 3D printing and biofabrication

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Research Topics:
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- Kinetics nanoscale and mesoscale diffusion
- Antimicrobial and cytocompatible coatings

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- Nanoscale surface characterization
- Biosensors for therapeutic monitoring

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- Biomaterials and tissue engineering
- Development of enabling delivery systems for diseases

COMPUTER SCIENCE

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Research Topics:
- Machine learning
- Data mining
- Biomedical informatics

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Research Topics:
- Machine learning and data science
- Systems biology
- Computational biology

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Research Topics:
- Creation of interactive media and visualization environments
- Developing custom technologies and intelligent applications
- Mechatronics, HCI and wearable technology, holography and stereoscopic 3D

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- Requirements engineering

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- Mobile computing, mobile sensing and wireless networks
- Cybersecurity, network security and privacy and trust
- Mobile (3G/4G) systems and Internet of Things (IoT)

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- Parallel, distributed and GPU computing
- Evolutionary algorithms and genetic programming

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- Information and system security
- Blockchain management and utilities
- Software engineering

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Research Topics:
- Software maintenance
- Software engineering
- Recommendation systems

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Research Topics:
- Network vulnerability assessment
- Security and privacy in social networks and wireless networks
- Approximation algorithm, combinatorial optimization

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- Network management
- Social networks

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Research Topics:
- Algorithms
- Complexity theory
- Quantum computation

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Research Topics:
- Modeling and simulation
- Systems biology
- Wireless networks

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Research Topics:
- Machine learning
- Data science
- Applied mathematics

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Research Topics:
- Machine learning, ensembles, imbalanced data, kernel methods
- Data stream mining, concept drift, active learning
- Medical informatics, clinical decision support, activity recognition

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Research Topics:
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- Intrinsic disorder in proteins
- Structural genomics

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- Energy security and resilience of critical infrastructures
- Virtual reality and medical applications

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- Natural language processing
- Biomedical informatics
- Nanoinformatics

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- Mobile computing
- Cybersecurity

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- Computer vision
- Intelligent systems

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- Computational Biology/Medicine
- Geriatrics/Gerontology

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- Cryptocurrencies and blockchain technologies
- Quantum (resilient) cryptography

ELECTRICAL & COMPUTER Engineering

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- Wireless medical telemetry (implantable and body-centric) and e-health
- Novel microwave antennas, arrays and sensors for military applications

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- Autonomic computing
- Cybersecurity and self-protecting systems

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- Micro and nanofabrication
- Sensors and actuators
- Energy conversion devices

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- III-nitrides for high-frequency high-power electronic and optoelectronic devices
- ZnO epilayers and nanostructures for electronic, optoelectronic and medical devices, photovoltaics and plasmonics
- Multifunctional oxides for passive RF devices

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- Coherent spin transport in nanowires for sensing and information processing
- Nanowire-based room temperature infrared detectors

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- Engineering education
- Nanofabrication techniques
- Molecular electronics

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- Medical image processing
- Digital signal processing algorithms
- Engineering education

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- Dependability analysis of safety critical systems
- Cyber physical systems

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- Machine learning for medical applications

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- Neural networks
- Linear and nonlinear control theory

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- Nonlinear optics
- Optical materials

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- Light emitting diodes
- Nitride semiconductor heterostructures

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- Medical imaging
- Computer vision

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- Information fusion and adaptive sensing in sensor networks
- Wireless communications and MIMO radar

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- Ultrafast optical spectroscopy
- Physics of semiconductor heterostructures

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- Compiler design
- Automatic generation of software

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- Renewable integration and demand side management
- Power grid vulnerability analysis

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- GPU and heterogeneous computing
- Emerging memory and storage technologies
- Embedded systems

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- Computer architecture
- Parallel computing

MECHANICAL & NUCLEAR Engineering

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- Nanoscale materials
- Radiation detection and measurement
- Polymer fibers and films

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Research Topics:
- Straintronics: energy efficient computing with magnetostrictive nanomagnets
- Voltage control of nanoscale magnetism and skyrmion dynamics
- Brain-inspired computing

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Research Topics:
- Nuclear thermal hydraulics
- Nuclear reactor design and safety
- Energy and environmental policy

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- Design engineering and design optimization
- Product innovation, design, fabrication and development methods
- Computer-aided design (CAD), computer-aided engineering (CAE) and engineering education

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- Surface engineering and functional coatings
- Materials under extreme environments
- Advanced materials, manufacturing and nanotechnology

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- Particle instrumentation and characterization
- Transport phenomena in multiphase systems

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- Liquid filtration
- Air filtration
- Air and particle pollution control

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- Nuclear nonproliferation
- Nuclear security
- Radiation detection and measurements

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- Pediatric lungs targeted drug delivery
- Aerosol filtration and bio-aerosols

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- Process automation

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- Peridynamic modeling and simulation
- Fracture and failure of ceramics, glasses and fiber-reinforced composites
- Multiscale computational solid mechanics

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- Biomagnetics and neuromodulation
- Magnetic materials and devices
- Energy harvesting

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- Targeted drug delivery
- Pharmaceutical aerosols

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- Engineering education
- Reactor simulation
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- Ultra-incompressible superhard materials
- Thin film deposition and characterization
- Superhydrophobic materials

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- Smart materials
- Sensors

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- Nuclear and chemical separation technology in fuel cycle research and development
- Electrochemical processes
- Special material detection and analysis via laser and mass spectroscopy techniques

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Research Topics:
- Radiation-induced synthesis of nanomaterials
- Radiation effects on nanomaterials and nuclear materials
- Nanostructures for nuclear science and technology

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- Tissue engineering
- Soft tissue biomechanics
- Modeling of biological processes

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Research Topics:
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- Radiation detection and measurement

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- Fluid, heat and particle transport through porous materials
- Separation science

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Research Topics:
- Aerosol processing of functional nanomaterials
- Heterogeneous catalysis for energy and the environment
- Smart luminescent materials for sensing and medical applications

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- Nuclear reactor physics
- Computational methods for neutron transport equation
- Data sensitivity and uncertainty analysis

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Research Topics:
- Surface science and surface engineering
- Transport and self-assembly of colloidal nanoparticles
- Printed functional devices and micro/nano additive manufacturing

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