



VCU

School of Engineering

RESEARCH 2 REALITY THE MOMENTUM CONTINUES





The Sky is the Limit

Just over a year ago, I joined Virginia Commonwealth University as dean of the youngest school on either campus.

At the time, I was impressed by the enthusiasm and the unquenched spirit I saw in both students and faculty. But perhaps I was most impressed by the school's potential for greatness.

I am still impressed by what I see every day –

- A legacy of student-centered learning to prepare the inter-disciplinary leaders of tomorrow
- Research that makes a positive difference in our community and to human kind
- A highly collaborative, creative, innovative and entrepreneurial culture
- A global, real-world perspective of engineering in the learning environment

These fundamental components of what the school represents are the basis of our strategic plan.

In keeping with the university's Quest for Distinction, our goals are to:

- Grow our student body while raising the bar for our student applicants
- Expand fulltime faculty
- Increase our funded research

- Achieve a top 50 ranking among the nation's top schools of engineering
- Achieve a graduate program ranking among the nation's top 25

As you'll see on the following pages, we're well on our way. You'll learn about our collaborations and our innovations, about our people and our facilities, about our approach to learning and our student successes.

There simply aren't enough pages to highlight all of our work. To all of our colleagues, partners and students, congratulations on a job well done.

We're proud of what we've accomplished in the past 12 months. And we look forward to what we've yet to do. The sky's the limit.

Thank you for your interest. I invite you to become a part of our world.

Barbara D. Boyan, Ph.D.

Alice T. and William H. Goodwin, Jr. Chair in Biomedical Engineering
Dean, VCU School of Engineering

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MEET OUR ASSOCIATE DEANS

Innovation & Outreach, Finance and Administration

Lewis Franklin Bost, MBA, IDSA, executive associate dean

L. Franklin Bost joined VCU in 2013 from the Georgia Institute of Technology where he was professor of the practice and executive director of the master of biomedical innovation and development program in the Wallace H. Coulter Department of Biomedical Engineering.

In addition to his academic background, Bost is president and chief executive officer of Spheringenics Inc., an early stage company focusing on enhancing the delivery and effectiveness of stem cell therapies. Previously, he was president of Porex Surgical Inc., a developer, manufacturer and distributor of implantable biomaterial products for craniofacial reconstructive surgery.

- M.B.A., University of North Carolina
- Bachelor of Product Design, North Carolina State University



Undergraduate Academic Affairs

Afroditi V. Filippas, Ph.D., interim associate dean

Associate professor in the electrical and computer engineering department, Filippas holds a diploma in electrical engineering from the University of Patras and a master's and doctorate degree in electrical engineering from the University of Texas.

Filippas plays a critical role in the development of supportive undergraduate programs such as the annual Senior Design Expo event. Her work assures students' collaborative success from project concept to completion and includes community partnerships and the development of real-world scenarios for out-of-classroom application.

- Diploma, electrical engineering, University of Patras
- M.S.E., electrical engineering, University of Texas
- Ph.D., electrical engineering, University of Texas



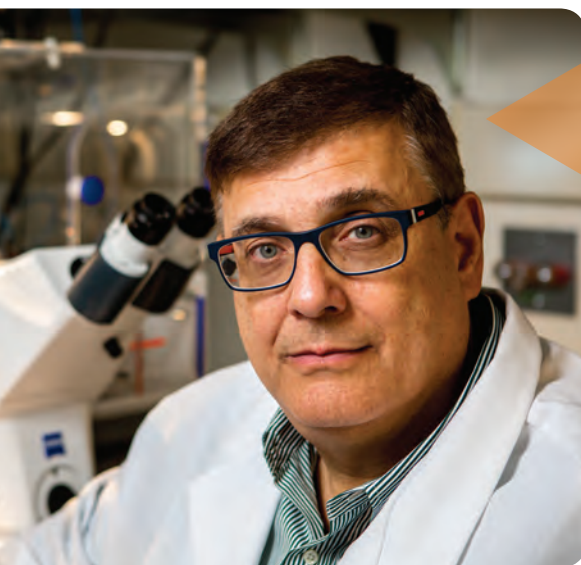
Strategic Initiatives

Zvi Schwartz, Ph.D., D.M.D., associate dean

Zvi Schwartz, one of the newest members of the Dean's office, is a biomedical engineering trailblazer whose research interests include periodontal diseases, the effects of various hormones and growth factors on endochondral bone regulation and the influence of different implant materials on bone formation. He is a professor in the biomedical engineering department.

Schwartz is widely published and holds memberships in a variety of professional memberships and societies. He has held professorships at The Hebrew University of Jerusalem (professor emeritus) and UTHCSA.




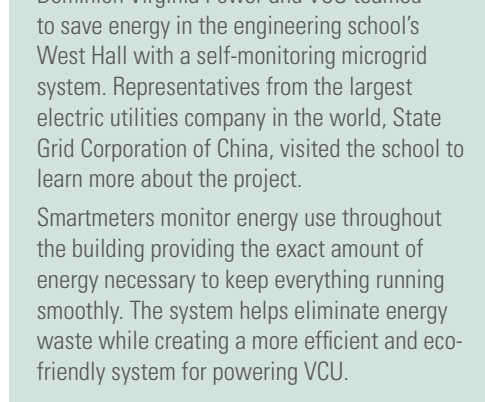
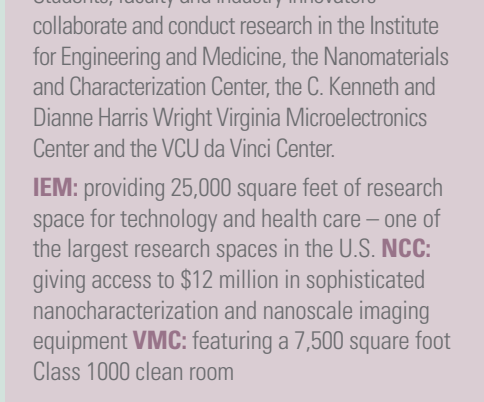
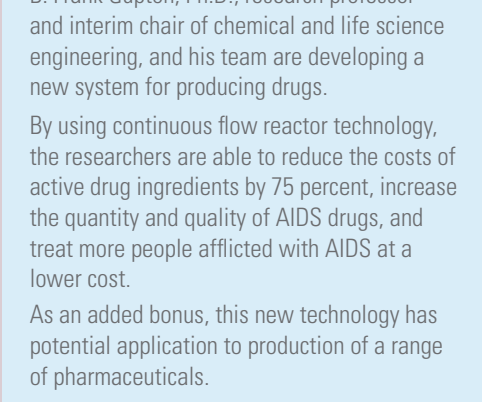
- D.M.D., dentistry, The Hebrew University, Hadassah Faculty of Dental Medicine
- Graduate training, periodontics, The Hebrew University, Hadassah Faculty of Dental Medicine
- Ph.D., experimental pathology, The Hebrew University, Hadassah Faculty of Dental Medicine



collaboration and innovation

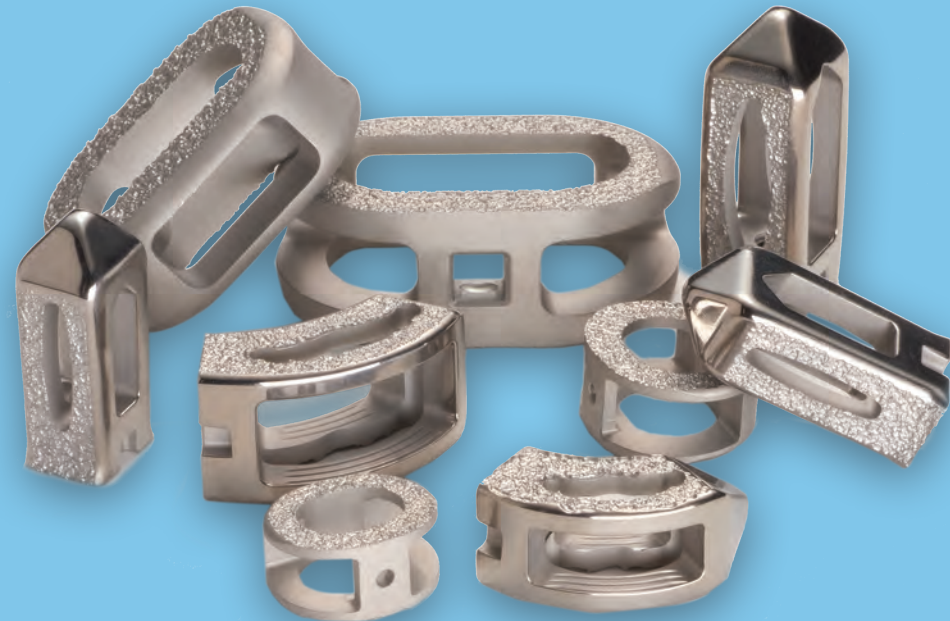
At VCU, working collaboratively is easy. We work with some of the world's best researchers, medical clinicians, systems and device designers, scientists and businesspeople on a day-to-day basis. Often, they are right across the hall or just across the campus.

It's this type of access and support that sets us apart. You'll learn more about many of these initiatives on the following pages.

<p>SUSTAINABILITY AND ENERGY ENGINEERING</p>  <p>The Power of the Microgrid: Saving Energy Dominion Virginia Power and VCU teamed to save energy in the engineering school's West Hall with a self-monitoring microgrid system. Representatives from the largest electric utilities company in the world, State Grid Corporation of China, visited the school to learn more about the project. Smartmeters monitor energy use throughout the building providing the exact amount of energy necessary to keep everything running smoothly. The system helps eliminate energy waste while creating a more efficient and eco-friendly system for powering VCU.</p>	<p>MICRO AND NANO ELECTRONIC SYSTEMS</p>  <p>Research and Collaboration: Premier Facilities Students, faculty and industry innovators collaborate and conduct research in the Institute for Engineering and Medicine, the Nanomaterials and Characterization Center, the C. Kenneth and Dianne Harris Wright Virginia Microelectronics Center and the VCU da Vinci Center. IEM: providing 25,000 square feet of research space for technology and health care — one of the largest research spaces in the U.S. NCC: giving access to \$12 million in sophisticated nanocharacterization and nanoscale imaging equipment VMC: featuring a 7,500 square foot Class 1000 clean room</p>	<p>PHARMACEUTICAL ENGINEERING</p>  <p>Fighting Back: Increasing Access to AIDS Drugs B. Frank Gupton, Ph.D., research professor and interim chair of chemical and life science engineering, and his team are developing a new system for producing drugs. By using continuous flow reactor technology, the researchers are able to reduce the costs of active drug ingredients by 75 percent, increase the quantity and quality of AIDS drugs, and treat more people afflicted with AIDS at a lower cost. As an added bonus, this new technology has potential application to production of a range of pharmaceuticals.</p>
<p>MECHANOBIOLOGY AND REGENERATIVE MEDICINE</p>  <p>Growing our Future: Biofabrication As one of the school's newest faculty members Xuejun Wen, M. D., William H. Goodwin Professor in chemical and life science engineering, began his research at the school by creating a robotic drug screening system to accelerate new drug development. His research focus is to develop clinically applicable tissue and organ repair strategies based on principles from tissue engineering and regenerative medicine. Wen plans to establish the VCU Center for Biofabrication, which opens new avenues of collaboration and provides support for small companies in the Virginia BioTechnology Research Park.</p>	<p>SECURITY AND MINING BIG DATA</p>  <p>Securing the Cloud: Protecting our Data Meng Yu, Ph.D., associate professor in computer science, is working with 11 students to develop security systems for private data stored on cloud networks. The team's key approach is to track and use various cause and effect relations in the system to support self-healing and automated responses. According to Yu, the most important aspect is privacy protection and strengthening service providers' capability of defense. The team is also working on attack-resilient networks, cognitive radio networks and visual security monitoring tools.</p>	<p>DEVICE DESIGN AND DEVELOPMENT</p>  <p>Strengthening Spines: Promoting Healthy Bone Growth Barbara D. Boyan, Ph.D., dean of the VCU School of Engineering, is working with researchers from VCU, Georgia Tech and Titan Spine LLC to create an improved method for fusing vertebrae. The team designed a spinal interbody fusion implant made from roughened titanium. The rough surface promotes bone and blood vessel growth, providing more nutrients and creating healthier fusion between vertebrae. This new method increases growth factors nearly 100 percent and reduces inflammation in the spine, making spinal fusions faster, stronger and less strenuous.</p>

Strengthening Spines

by Promoting Healthy Bone Growth



Barbara D. Boyan, Ph.D., dean of the School of Engineering, is working with researchers from VCU, Georgia Tech and Titan Spine, LLC to create an improved method for fusing vertebrae.

The team designed a spinal interbody fusion implant made from roughened titanium. The rough surface promotes bone and blood vessel growth providing more nutrients and creating healthier fusion between vertebrae. This new method increases growth factors nearly 100 percent and reduces inflammation in the spine, making spinal fusions faster, stronger and less strenuous according to a new preclinical study led by Boyan.

In the study, published online in *The Spine Journal*, researchers compared the production of cellular growth factors involved with both bone and blood vessel formation by bone cells cultured on two different environments – a smooth titanium alloy surface as well as a material commonly used for spine implants, poly-ether-ether-ketone, or PEEK. In addition, cells were cultured on a new proprietary implant surface technology created by Titan Spine, LLC, a medical device company.

Studies demonstrate that rough titanium alloy surfaces increased production of the necessary growth factors by nearly 100 percent, compared to the PEEK and smooth titanium alloy materials.

“This means that by modifying titanium alloy surfaces to stimulate bone

cells to produce these important factors, surgeons may be able to improve the performance of spine cages and, as a result, quality of care for their patients,” Boyan said. “Future work will lead to a better understanding of how surface design can impact the inflammation associated with spine implant surgery.”

Spinal fusion may be a necessary surgery for patients with broken vertebrae, deformities of the spine, herniated disks or chronic low back pain to permanently connect two or more vertebrae in the spine to eliminate motion between them.

In order for spinal fusion to occur, an environment conducive to supporting bone formation and remodeling must be created to promote growth of bone and formation of blood vessels to provide nutrients and sustained bone health. Past research has focused mainly on bone growth factors and has overlooked blood vessel factors.

“Our goal is to help surgeons improve the quality of care for their patients.”

– Barbara Boyan, Ph.D., dean of the School of Engineering



An Early Start: Preparing for the Next Generation of Biomedical Professionals

The school’s legacy of student-centered learning designed to prepare the engineering leaders of tomorrow now includes giving students an early start before they ever reach the university.

At the invitation of the Virginia Department of Education’s Office of Career and Technical Education Services, Gerald Miller, Ph.D., professor and chair of the biomedical engineering department, served on a team of technical experts who reviewed the bioengineering curriculum used in Virginia’s public high schools.

The team of five met during an all-day session with a goal to bring the 11th and 12th grade curriculum up to date and to be sure that today’s cutting edge best practices were included in the teaching material framework.

Miller was in good company: teammates included participants from Tetracore, Altria, algorithmRx and Engineered BioPharmaceuticals.

With a B.S. in aerospace engineering and M.S. and Ph.D. in biomedical engineering, all from Pennsylvania State University, Miller was a natural for the team. His research interests include rehabilitation engineering, man-machine interfacing and artificial hearts.

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STRESS and TENSION:

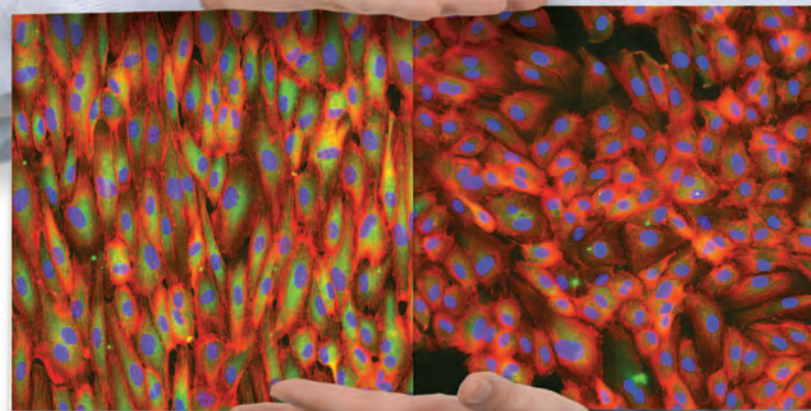
Measuring Force Across Proteins



For Dan Conway, assistant professor in the biomedical engineering department, stress and tension are critical to his research.

"The question I've always had is about the force that cells exert on a surface or on another cell," he explains. "There are many proteins in different regions and it's very difficult to ascertain which protein is bearing a load. Do different stimuli change the load on a particular protein? Does the tension switch from one to another?"

The answers may hold a key for significant health care applications.

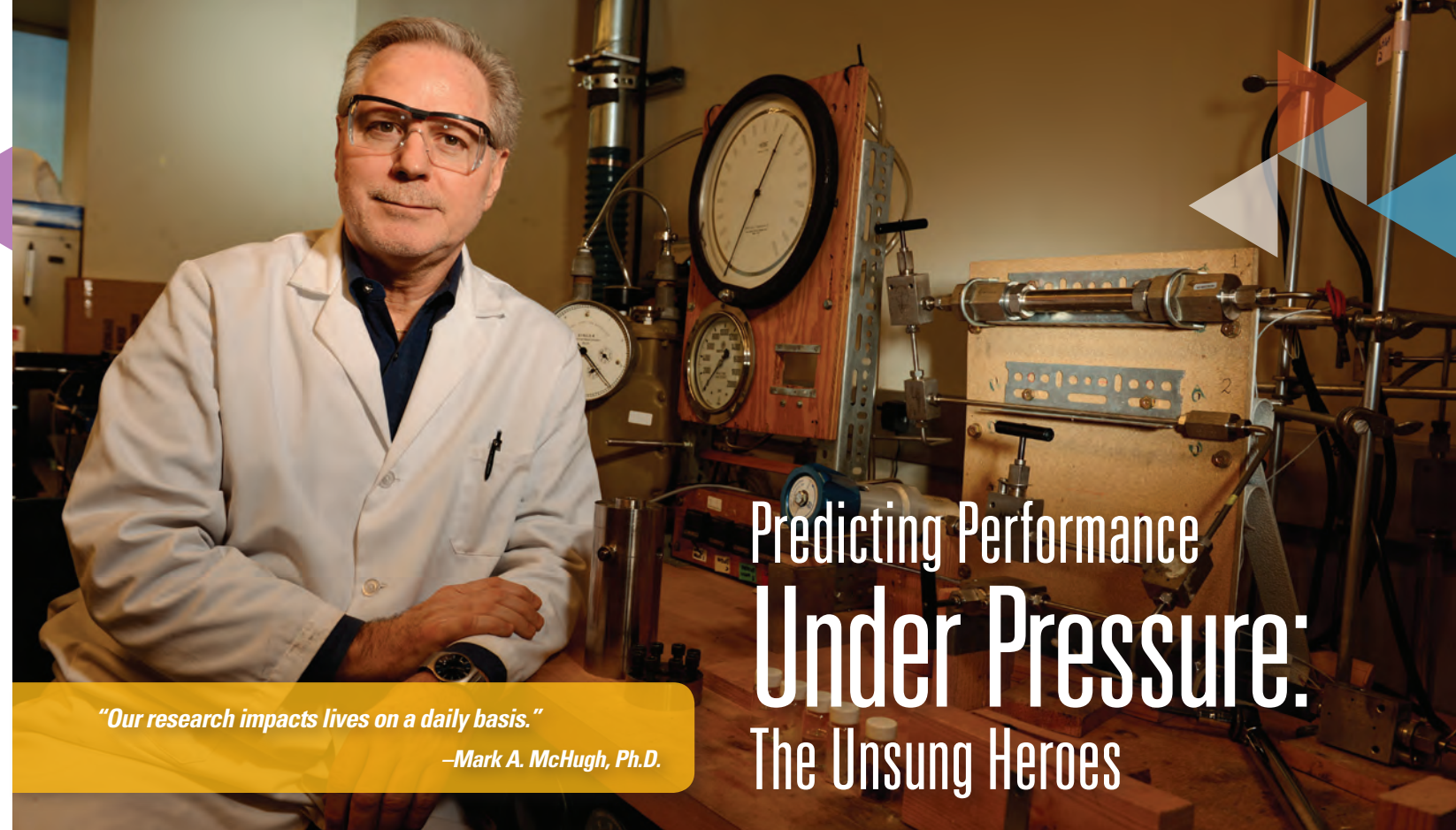


Tension sensor research puts Conway one step closer to a variety of health care advancements. The images to the left show cells under fluid shear stress.

Conway's "tension sensor" research allows him to measure the force as well as cellular reaction to a variety of stressors.

"I'm looking at endothelial cells and how they respond to blood," he said. "They're obviously exposed to a variety of different forces. Blood flowing across them and pumping the heart can create force and they respond dramatically."

Knowing the how's and why's of these responses puts him steps closer to advancements in vascular function and disease research.



"Our research impacts lives on a daily basis."

—Mark A. McHugh, Ph.D.

Predicting Performance Under Pressure: The Unsung Heroes

From improving automotive efficiency to enhancing food flavors, more often than not, chemical engineers have a hand in transforming the products most consumers encounter every day.

The role of the chemical engineer is so vital that one of the world's largest chemical companies built a campaign around work that no one ever sees: "We don't make a lot of the products you buy, we make them better™."

Mark A. McHugh, Ph.D., professor in the school's chemical and life science engineering department, is one of the unsung heroes who works to enhance performance in a variety of products.

"Our research helps understand how molecules behave when subjected to conditions of high temperatures and pressures," he said. "Two major funders are the Department of Energy and Afton Chemical Corporation, which highlights how our research combines fundamental studies with engineering applications."

His lab's most recent work provides a basis for the efficient recovery of petroleum fluids from ultradeep reservoirs at extreme temperatures and pressures.

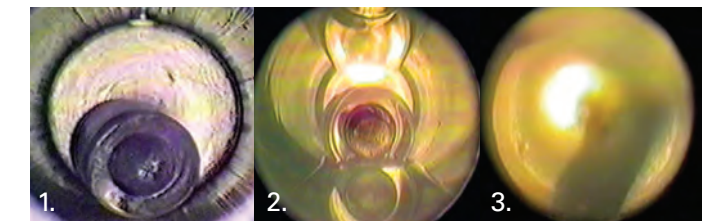
His research also impacts automobile performance. While advances have been made in engine design, automotive efficiency can be increased with additives that minimize energy loss and function at very harsh operating conditions.

"We use our experimental results to test contemporary equations of state used to predict solution properties," he said. "We study the behavior of model compounds to provide insight for the design

of efficient fuel additives or lubricants and we also study how polymers enhance the behavior of fluids specifically formulated as friction reducing additives for targeted applications. Our research provides the basis for interpreting advanced fluid behavior that ultimately can have a large economic and environmental global impact."

The key to unlocking the benefits of these compounds, he explains, requires a fundamental understanding of how molecular architecture affects solution properties.

"Our research design is based on the principles of physics, chemistry and advanced mathematics. These are the tools of chemical engineers."



Through the Borescope: Merging Under Pressure

Three stages of using pressure to probe alcohol - carbon dioxide molecular interactions. Figure 1 shows these components split into a vapor bubble and a liquid phase at 40° C and 100 atm pressure. At a slightly different pressure three phases now emerge - vapor, liquid, liquid - in Figure 2. The solution ultimately solidifies as the pressure is further increased in Figure 3. In the McHugh lab, observation of the phases in equilibrium at high temperatures and pressures provides the information needed to interpret fluid behavior in a variety of applications.

Creating Opportunities for Student Growth

While a graduate student at the University of California, San Diego, Stephen Fong completed the first study that used large-scale metabolic modeling to design and implement novel chemical production into organisms. Three design strategies were identified to produce lactic acid from the bacterium, *Escherichia coli*.

Today, as associate professor and associate chair in the chemical and life science engineering department, Fong's passion for student learning is just as contagious.

"I always wanted to be an educator, to help foster opportunities for students," he said. "I wanted to make a positive impact and give people opportunities. It's great when you have a student and you see them flourish in their experience and then move on to other things. That's what I wanted."

Both undergraduate and graduate students have opportunities in Fong's lab to explore, to grow and to discover. As a bioengineer, Fong works with real-world challenges almost on a daily basis.

"We encourage students to get involved in research as early as possible. It's

a different learning environment. For some, undertaking research is intimidating. They don't know what to do and wonder, 'How do I take the first step?' We take away the barriers by asking them to picture themselves contributing to something they're passionate about. From the environment to consumer products. It's very different from the classes they're used to taking. Real-world problems encourage open ended, free thinking."

For nearly a decade Fong has been a positive influence in the lives of many students. The secret to engagement, he says, is to listen.

"There's not one magic key, but for me, listening is very important. It's flipping the paradigm where professors talk at students. For me, it's the opposite.

Students want their voices heard. The ability to listen comes across in a lot of different ways. If you don't engage, you just keep going through your material. I can look at the class and realize if

they 'get it' or not. If not, I may say, 'Let's think of another example of what we're talking about,' that's when I hear a collective exhale. I know they're going to get it!"

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– Stephen S. Fong, Ph.D.

Stephen Fong, center, with several of his past and present doctoral students. From left to right, Niti Vane, Ph.D., Integrative Life Sciences; Adam Fisher, a Ph.D. student in the Integrative Life Sciences Program; and George McArthur IV, Ph.D., Chemical and Life Science Engineering.



Fighting Back: Increasing Access to AIDS Drugs

Frank Gupton, Ph.D., research professor and interim chair of chemical and life science engineering, and his research team are developing a new system for producing drugs and leading efforts to help make AIDS drugs more accessible.

Supported by the Bill, Hillary & Chelsea Clinton Foundation's Health Access Initiative, the team has identified a process that reduces the costs of active drug ingredients by 75 percent and uses continuous flow reactor technology to provide greater control over medication quality. The team is made up of scientists and engineers from VCU and Florida State University.

Only 5.2 million of the 33 million AIDS and HIV-infected individuals received anti-viral drugs in 2011, according to the World Health Organization. To combat the growth rate of AIDS, Gupton's goal is to reduce the cost and increase the quantity and quality of anti-viral drugs – all factors in slowing the spread of AIDS.

"Initially, the goal was to produce around 700 tons of the drugs through a process that could be implemented globally," Gupton said. "This took me by surprise because the quantities were significantly greater than what we had ever produced commercially and it got me thinking about an entirely different approach to the problem."

The production of drugs through this novel approach has attracted the National Aeronautics and Space Administration and U.S. defense experts, since it could provide access to medicines in space or a battlefield.

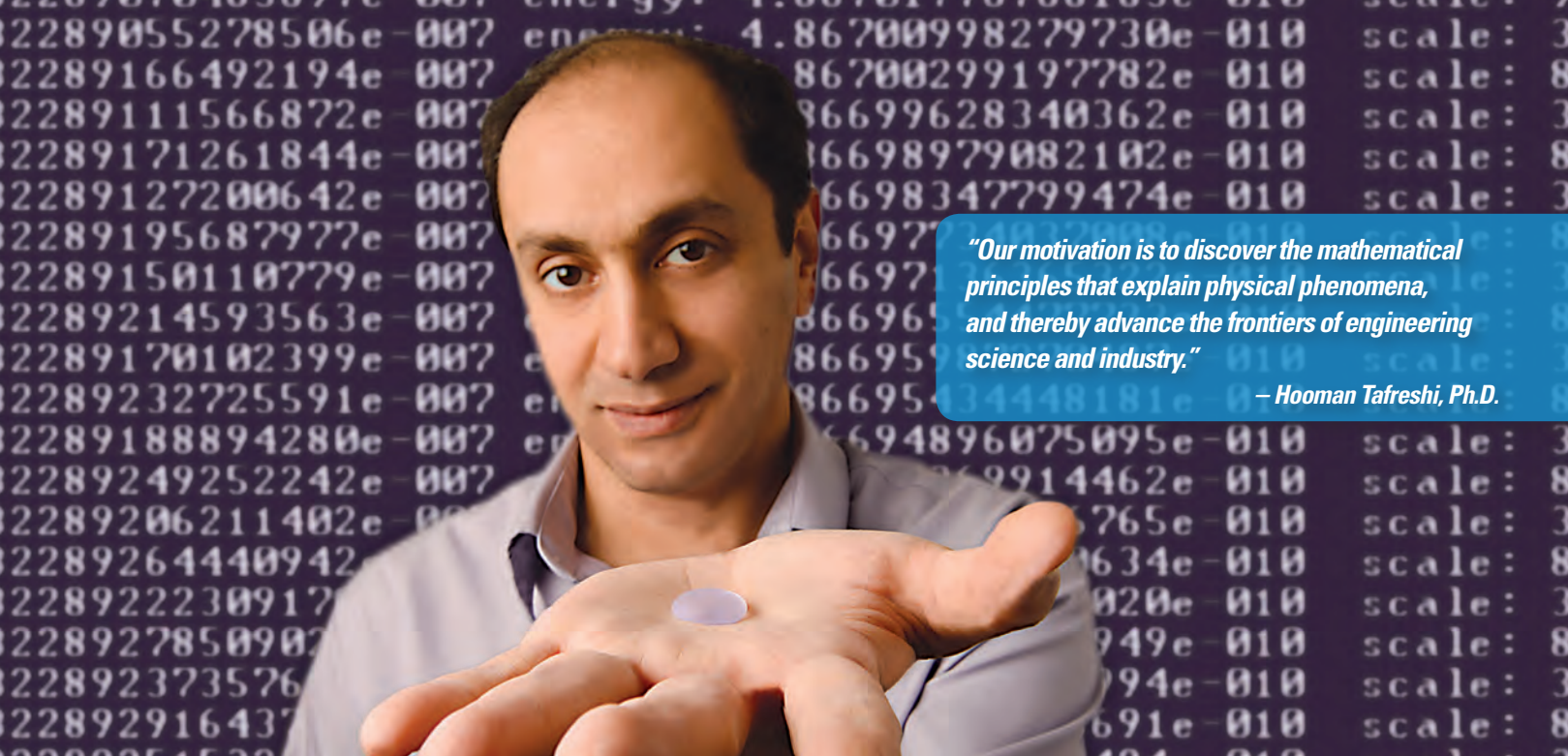
After 31 years in the pharmaceutical industry, Gupton joined VCU in 2007 when it offered him time to explore the development of innovative chemical processes with pharmaceutical applications.

"What I wanted to do when I came here was to work on fundamental problems that I had experienced in industry," he said.

As executive director of process development at a major pharmaceutical company, Gupton spearheaded the development of the commercial process that brought forth Nevirapine, one of the three components used in combination drug therapy for the treatment of AIDS.

"The AIDS-infected patient population is growing at a rate of about 14 percent globally a year," Gupton said. "If we maintain that rate, the number of infected patients will double about every five years."

– B. Frank Gupton, Ph.D.



"Our motivation is to discover the mathematical principles that explain physical phenomena, and thereby advance the frontiers of engineering science and industry."

— Hooman Tafreshi, Ph.D.

From Diapers to Submarines: Studying Porous Materials

Diapers and submarines may seem worlds apart, but there's at least one thing in common between the two: fluid mechanics.

This is the work of Hooman Tafreshi, Ph.D., associate professor in the mechanical and nuclear engineering department. Here, he and his graduate students work to develop engineering science for next-generation industrial products.

"We work with porous materials and develop the mathematical framework to predict their behavior in different applications coming from environmental or energy concerns," he explains. "In our research with superhydrophobic surfaces, for example, the main objective is to minimize the energy required to move an object, such as a submarine, under water. We derive theories to predict and improve the performance of the surface, and draw a roadmap for future exploration in the field."

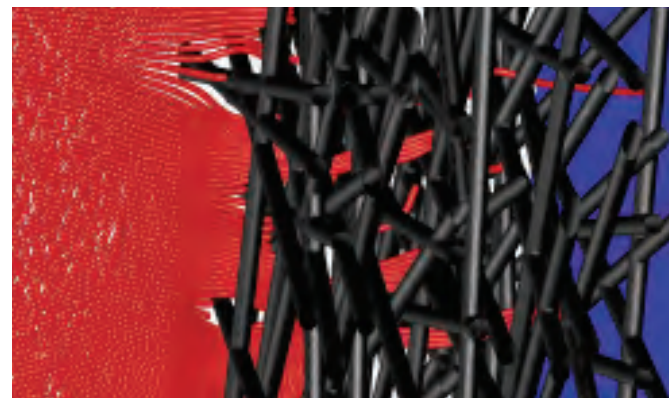
Tafreshi and his team are internationally recognized for their research on the flow of multiphase fluids through fibrous materials.

"Another major part of my work involves the transport of fluid, heat and particles through fibrous materials. Diapers, once thick and clumsy, are now very thin and conforming, thanks to continuing research in the field of porous materials. The challenge is to design an absorbent product that works faster and protects against leakage while still being affordable. The key is how to design such porous media, and for that you need mathematics and physics, or simply fluid mechanics."

The team's current research includes designing superhydrophobic porous surfaces for underwater applications, the physics of which is like an absorbent

material working the other way, repelling water instead. Tafreshi has more than 90 journal publications in these and other related areas of thermo-fluid sciences such as aerosol filtration and heat insulation.

"A satisfying part of what we do is that we work to discover the first principles describing a phenomenon. Once we figure that out, we only need to formulate it," Tafreshi said. "The answer is there, waiting for you to see it. If one simply looks at a diaper with an open mind, one may suddenly stumble on a way to make a ship sail faster!"



(top image) Dr. Hooman Tafreshi's palm, coated with a superhydrophobic material, provides just the right surface for water resistance. (above) The trajectory of a group of aerosol particles with a diameter of 500 nm (shown in red) as they penetrate through a virtual electrospun fibrous media.

Unique Hybrid M.S. Degree Now Offered Online

For well-qualified professional engineers looking to broaden their skills or obtain a graduate degree, in-classroom learning isn't always an option. Life and work schedules often get in the way, and required graduate-level courses may not be available nearby.

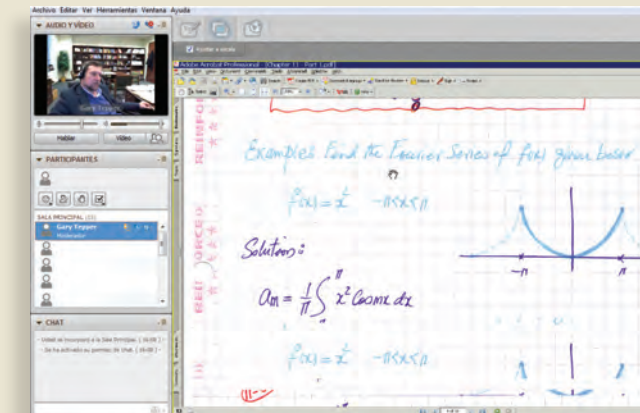
Following the 2012 introduction of the nation's first hybrid Ph.D. program, the Department of Mechanical and Nuclear Engineering now offers a hybrid online M.S. program in mechanical and nuclear engineering.

"Ours is a unique program," said Karla M. Mossi, Ph.D., professor and director of graduate studies, Department of Mechanical and Nuclear Engineering. "It combines two complementary engineering disciplines that we're offering synchronously online. We started the program with two pilot classes of 14 students, most of who were employed at Newport News Shipbuilding. Another student, a Dominion employee, took classes in South Carolina after being transferred there from Virginia. It's a beautiful opportunity for many companies. Employees don't have to be sent away for classes. It's a very helpful option for them. And it's the very same program a student would get on campus."

Nuclear Engineering, Thermal Fluid Sciences, Dynamic Systems and Controls are some of the courses that are offered with the program.

"The VCU Center for Teaching Excellence helped us tremendously," Mossi said. "We're still very traditional in our approach. They've helped us learn to deliver the courses in an online environment. It's been a tremendous challenge and it's been wonderful."

As class sizes grow, more companies are developing partnerships with the school and view the program as an employee benefit, Mossi explained.



DISTANCE LEARNING DIRECTOR NAMED



James E. Ames IV, Ph.D., associate professor emeritus, has been named Director of Distance Learning Programs and CGEP Program Director. His work involves the coordination of the school's efforts in developing and providing distance and online education. He assists in the development of new programs and helps individual faculty with their courses.

"The VCU School of Engineering offers several programs that cannot be found elsewhere," Ames said. "There are many faculty members and administrators who are very interested in exploring more online and distance education paradigms that would make VCU unique in the way that we approach this kind of education."

The school offers an online M.S. degree in mechanical and nuclear engineering and, through the Commonwealth Graduate Engineering Program, a M.S. degree in computer science, available at the Naval Surface Warfare Center, Dahlgren Division, Dahlgren, Va.

VCU recently celebrated its 30-year partnership with CGEP, a collaborative distance education initiative to provide graduate engineering and professional development to Virginia's working engineers.

"The VCU School of Engineering offers several programs that cannot be found elsewhere,"

— James E. Ames IV, Ph.D.

Cross-Campus Collaboration: Continued Success

Worth Longest, Ph.D., professor of mechanical and nuclear engineering, and Michael Hindle, Ph.D., research associate professor in the Department of Pharmaceutics in the Virginia Commonwealth University School of Pharmacy, continue to make great strides in their therapeutic pulmonary drug delivery research.

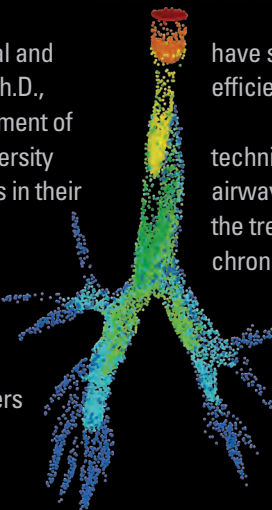
Longest, an aerosol dynamics specialist, and Hindle have developed new handheld dry powder inhaler devices that reduce drug loss in the mouth and throat from 60 to 90 percent. Typically, only 10 percent of a drug delivered by way of inhalers actually reaches the lungs; the rest goes into the mouth and throat and is swallowed. Experiments

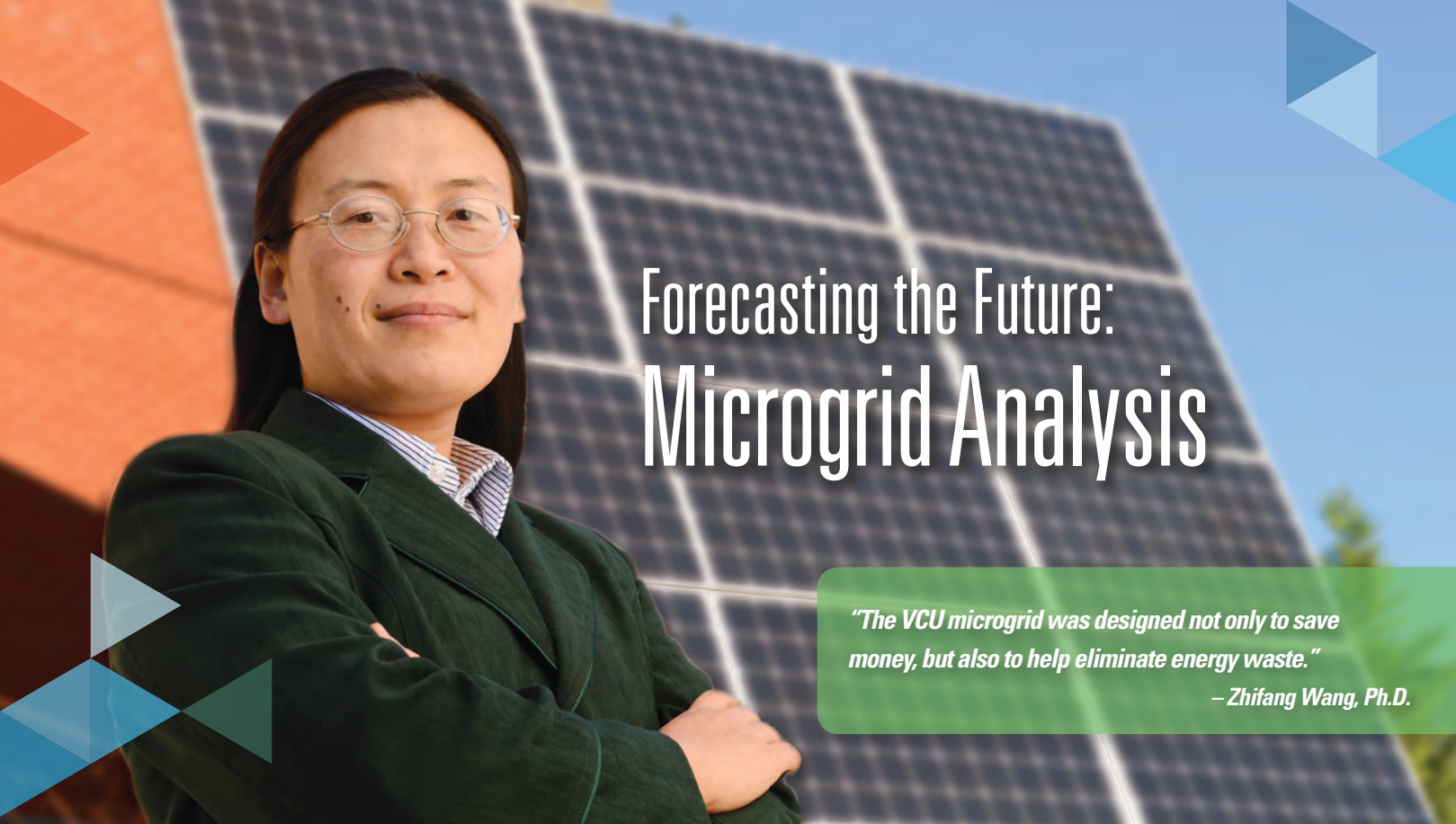
have shown a dramatic improvement in drug delivery and efficiency through the use of nanoparticles.

The two have also pioneered a nanoparticle lung delivery technique shown to increase drug dose (targeting) to the small airways by a factor of 20 to 30 fold, which can potentially improve the treatment of diseases affecting the small airways such as chronic obstructive pulmonary disease and respiratory infections.

They have also developed devices to improve aerosol delivery during mechanical ventilation from less than 10 percent to near 90 percent.

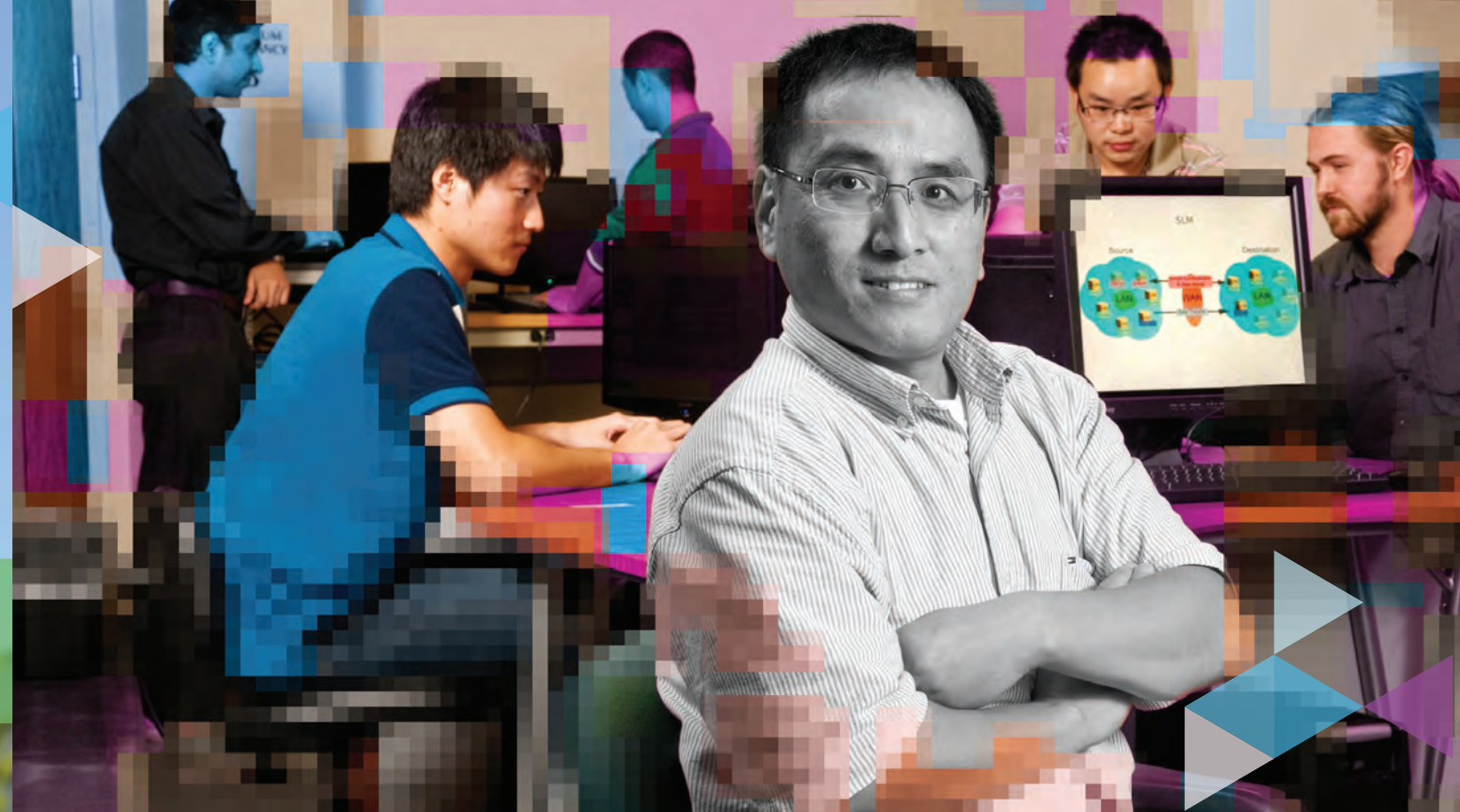
Experiments have shown a dramatic improvement in drug delivery and efficiency through the use of nanoparticles.





Forecasting the Future: Microgrid Analysis

*"The VCU microgrid was designed not only to save money, but also to help eliminate energy waste."
— Zhifang Wang, Ph.D.*



Being stuck in an elevator is never a pleasant experience, but for 14 minutes Zhifang Wang, Ph.D., assistant professor in the electrical and computer engineering department, enjoyed having a captive audience. Especially members of the largest electric utilities company in the world: State Grid Corporation of China. The visitors were at Virginia Commonwealth University to learn about the school's microgrid project.

In the elevator, Wang shared the results of a microgrid electric load analysis and forecasting project that her graduate class, "Introduction to Power Grid and Smart Grid," finished after a year of studying the self-monitoring microgrid system. The system, a five-year test site for a VCU partnership with Dominion Virginia Power, was designed not only to save money, but also to help eliminate energy waste. It also helps create a more efficient and eco-friendly power source for the university.

Beginning with three large green voltage regulators at the southeast corner of the school's West Hall, Wang explained how the project worked.

"We analyzed and modeled the building's electric load data, as well as the data from a bulk power grid obtained from the United Kingdom national grid," Wang said. "Our research revealed the strong correlation between the microgrid electric load and the local weather. We recognized three different types of daily electric load patterns in an institutional microgrid – weekdays, weekends and holidays. We then proposed a novel forecast model based on our analysis to expedite

the computation and improve the forecasting accuracy."

The Chinese visitors were impressed with what they saw, Wang explained. "They appreciated the industry-university collaborative effort of Dominion and VCU."

Wang was happy to learn of the microgrid collaborative at VCU even before she arrived from the University of California, Davis.

"I'm very thankful to be at VCU and to have this opportunity to do my research and educate the next generation of power engineers. It's a very supportive and nurturing environment."

Her research focuses on cascading failures in power grids, energy system modeling and optimization, integration of renewable generation into power markets and voltage stability and controls.



One of 200 Greenlet electrical outlets installed in the School of Engineering's West Hall as part of its microgrid. The outlets help control power consumption by fine tuning the delivery of electricity based on demand. Utility representatives from China toured the facility to learn more about the VCU microgrid.

A Cost Effective Solution To Big Data Storage

Xubin He, Ph.D., associate professor in the Department of Electrical and Computer Engineering, is about to change the way big data is managed in large data centers such as Google and Facebook.

His research team along with collaborators at IBM Research in Austin, Tx., and Huazhong University of Science and Technology in Wuhan, Hubei, China, is using mathematic coding theories to create a reliable and inexpensive solution to big data management.

"My research is focused on data storage because storage is critical," He says. "It's not like a decade ago when computation power was king and everyone was talking about fast computers. Now everyone talks about data and how to manage it efficiently. People can tolerate a slightly slower computer, but nobody can tolerate data loss."

Most storage solutions are based on multi-replication techniques where data are replicated across storage nodes for access, but these techniques are costly, redundant and insufficient for big data management.

"Replication is not efficient," He said. "We're using a technique known as erasure codes to group data into smaller, manageable pieces at a lower cost to achieve high reliability."

The process cuts costs without cutting access or reliability.

He's work led to a National Science Foundation award for his Storage, Technology and Architecture Research (STAR) lab and a \$430,000 grant in 2012.

Erasure codes help protect data loss by dividing data into smaller fragments and encoding them with some marginal extra data pieces. These fragments allow the original data to be recovered from a subset of these pieces that permits some pieces to become lost, or erased.

"In an erasure code configuration of (6,10) where we divide an original file into six pieces and store them on 10 disks (or locations)—along with four redundant pieces, the file can be recovered from any six out of these 10 disks (or locations). In other words, we can have up to four disk failures without data loss in this particular scenario."

The research applications can affect many areas of big data such as social media, e-business and health care, which are typically data intensive.

"People can tolerate a slightly slower computer, but nobody can tolerate critical data loss."

—Xubin He, Ph.D.



Cloud Security Programs: One Step Closer to Reality

*"The most important aspect of our work is privacy protection."
— Meng Yu, Ph.D.*

Millions of people routinely create and share documents through Google Drive or publish posts through blogging platforms. No matter the application – from photo sharing or homeland security – users expect “cloud” sharing to be easy and, most of all, secure.

Meng Yu, Ph.D., (above left), associate professor in the Department of Computer Science, is directing research projects through his Computer and Network Security Lab to identify vulnerabilities, threats and cyber attacks targeted to computer systems and cloud networks.

A \$50,000 I-Corps grant from the National Science

Foundation, allowed Yu and David Jackson, (above right), a Ph.D. student, to participate in a 2013 training program designed to teach researchers how to translate their work into real-life business applications.

Designed to replicate the customer discovery phase, the training helped the team test the viability for taking their cloud security platform to market.

“It’s one thing working in a lab. It’s another to be working on real-world problems,” said Pete O’Dell, a technology executive and member of VCU’s Industrial Advisory Board who served as the team’s mentor.

Computer Programming for Artists: A New Collaboration

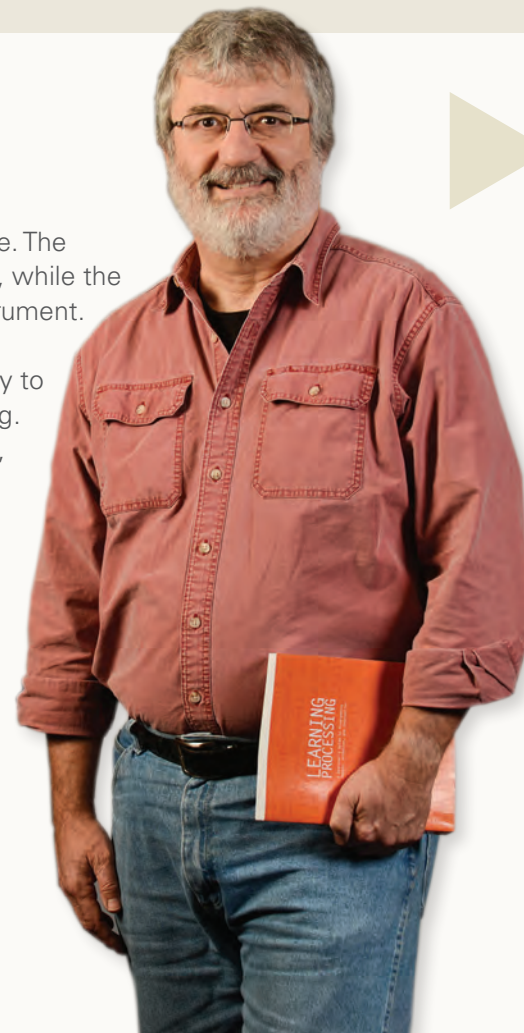
Artists require basic skills and knowledge – no matter the medium or practice. The painter must understand color and master the use of the brush and canvas, while the musician must understand music theory and embrace the use of their instrument.

R. Daniel Resler, Ph.D., associate professor of electrical and computer engineering, says many artists find their artistic creativity hindered by an inability to learn and master a modern and somewhat esoteric skill: computer programming.

“Artists can find themselves in situations where they can imagine their art, but cannot actually create it without programming knowledge,” he explains. “Often they set out on their own to learn, but may fail when they attempt to learn how to think computationally.”

To provide art students with the basics of coding, Resler is leading a new collaboration with the School of the Arts. Taught in the engineering computer lab, the program combines lecture and studio class with critiques, projects and quizzes.

*"Artists can find themselves in situations where they can imagine their art, but cannot actually create it."
— R. Daniel Resler, Ph.D.*



Diversity Effort Hosts High School Students to Experience STEM Studies

As part of a growing student diversity recruitment effort, the school has launched Engineers2B, a new program to bring small groups of high school students to campus for a real-life experience in engineering and computer science studies.

Under the direction of Lorraine Parker, Ph.D., the school’s new Director of Diversity and Student Programs, the first group of Engineers2B participants visited campus from the Richmond Technical Center STEM Academy’s Engineering track.

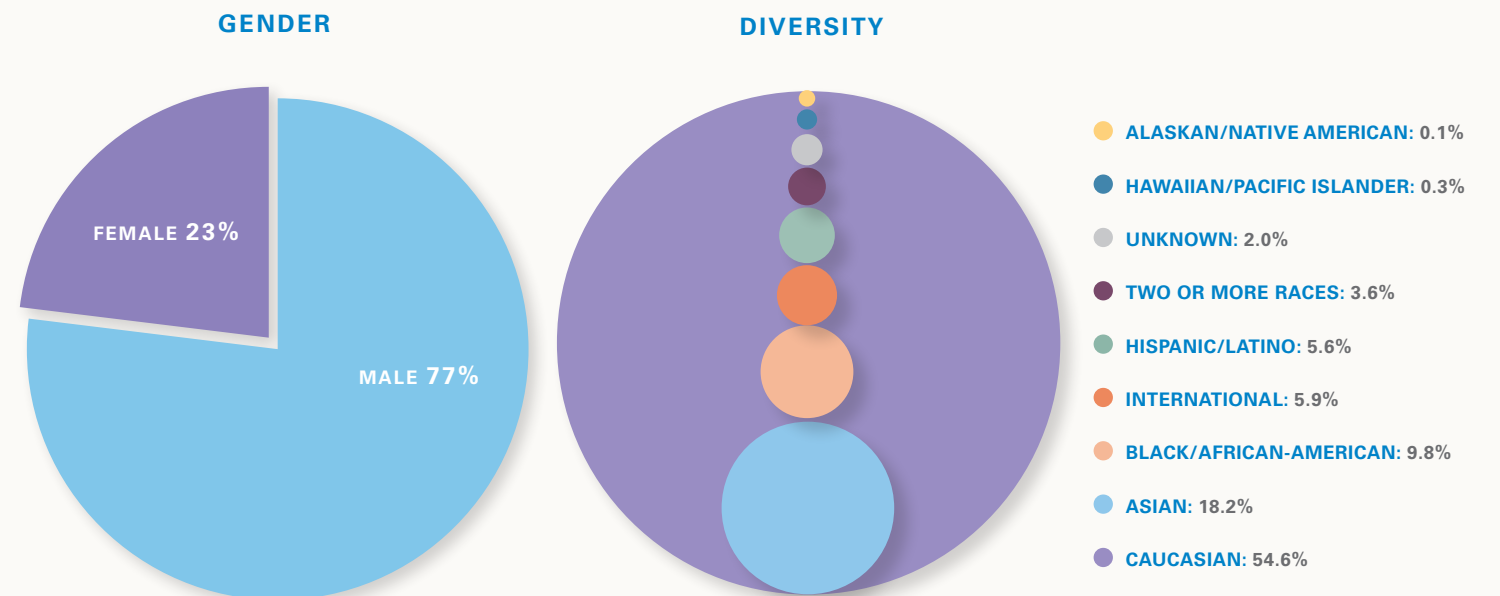
A group of six seniors attended two freshman level engineering course lectures, toured the engineering building with undergraduate student guides and had lunch with current student members from the National Society of Black Engineers. The Biomedical Engineering department hosted a day-long event in research to earn a “VCU Engineering Havoc” patch. And a group of Boy Scouts participated in a day-long event in the Mechanical and Nuclear engineering departments to earn a merit badge.

“Bringing groups of students to campus is valuable because it can help students, feel comfortable and makes college more of a reality to them,” Parker said. “For other students the benefit lies in being exposed to engineering, which isn’t offered in many high schools, and also to experience what the VCU School of Engineering has to offer.”



*"Bringing groups of high school students to campus is valuable because it can help students feel comfortable and makes college more of a reality to them,"
— Lorraine Parker, Ph.D.,*

VCU SCHOOL OF ENGINEERING UNDERGRADUATE STATISTICS



ENGINEERING in the community

We make a point to reach outside our walls to expose the broader community to the challenges, thrills and joys of engineering. These are only a few of the highlights from recent outreach activities in Richmond and beyond.



Alumni success



Less Invasive Drug Delivery

Patients affected with Type II diabetes manage their blood sugar with an insulin pump – a lifesaving, but cumbersome apparatus. **Gymama Slaughter** (B.S./chemistry/'01; M.S./chemical engineering/'03; Ph.D./electric and computer engineering/'03) is researching a novel method for drug delivery designed to be less invasive, specifically for people suffering from diabetes.

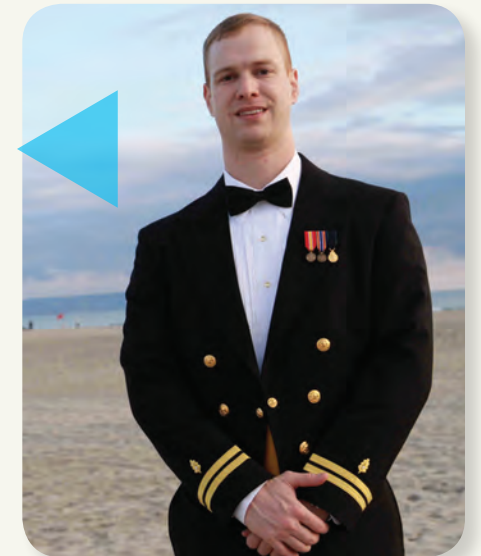
She has been recognized by the National Science Foundation as a CAREER Scholar, which provides financial support and public recognition for junior faculty members who exemplify the role of teacher-scholar through their research.

Slaughter is a faculty member at the University of Maryland, Baltimore County, in the Department of Computer Science and Electrical Engineering.

VCU Engineering is Launch Pad for Flight Surgeon

Lieutenant Robert Filler (B.S./biomedical engineering/'08; M.D./'12), Ph.D., comes from a family with a tradition. His grandfather and father were both career naval aviators, and Filler continues this tradition, but in a different vein. Instead of engaging the enemy, Filler is keeping his fellow soldiers healthy, safe and, in desperate situations, alive.

Filler credits professor and Chair of the biomedical engineering department, Gerald E. Miller, Ph.D., with helping him discover his interest in the field. He is also grateful for his senior design adviser, associate professor Paul A. Wetzel, Ph.D., who helped the team take their design for a hands-free, eye-controlled mouse to patent application.



Real-World Student Experience Leads to Career

Audrey Ayeung's (biomedical engineering/'13) experience while pursuing her degree served her in good stead. By her junior year, she was working with engineers at the Karlsruhe Institute of Technology in Germany to help design equipment for the detection of seizures.

By her senior year, she was working at an internship with Health Diagnostic Laboratory in Richmond, Va., and, after three months, was extended an offer for full-time employment. She and her team develop devices, now in the testing phase, to create a more environmentally sustainable laboratory.



Innovator, Educator and Engineer

Oscar Martin (Ph.D./chemical engineering/'09) started climbing the ladder at DuPont Chemicals in 1997. From developing medical fabrics to managing product development and technical service teams, he's built his career by blending chemistry with engineering principals.

Today, he is the company's chief innovation officer providing strategic direction for the technology and market development organizations for DuPonts Teijin Films Americas.

In 2009, he launched a Web-based educational company, TechnologyEd.com, which now hosts nearly 300 online courses ranging from polymer science to supply chain management. Martin has five patents under his name and is current president of the VCU School of Engineering Alumni Board.

STUDENT success



Senior Design Expo '13

Eight of 67 teams took top awards at the annual Senior Design Expo. The event brought together senior engineering students and their faculty advisers with judges from business and industry, including representatives from Amazon, DuPont Teijin Films, Evonik Goldschmidt, Flexicell and others. Many of the companies provided grants, equipment and advisers to assist the student teams.

Seniors conceptualized projects to improve human life and advance technology and research. The projects are the capstone of their studies and a graduation requirement.

(from left) Harrison Ngo, Sujan Adhikari and Daniel Klinefelter accept award from Dean Barbara Boyan, Ph.D. for their multidisciplinary project to help patients suffering from life-threatening breathing illnesses.



NANT Fellowship Awarded to Former High School Teacher

There was one piece of advice for **Jordan Garroway's** students who showed curiosity in his physics class at John Randolph Tucker High School in Richmond, Va. "If you're truly interested in this material, you really ought to consider engineering."

Years later, he took his own advice and enrolled in graduate school in the Department of Mechanical and Nuclear Engineering with plans to become a design engineer. After attending part time, he received a \$25,000 fellowship from the National Academy for Nuclear Training to cover the 2013-14 academic year.



VCU Turns in Its Best Performance in Regional Programming Contest

Six teams of Computer Science students competed in the Association for Computing Machinery's Mid-Atlantic International Collegiate Programming Contest at the University of North Carolina at Chapel Hill. Team RAMS 1 finished 29th out of 191 teams. Teams RAMS 3 and RAMS 5 placed in the best 25 percent overall. The results were the best in the school's four-year history of participating in the event.

Sponsored by IBM, the ACM-ICPC is the oldest, largest and most prestigious programming contest in the world.



Graduate Student Wins Walmart New Product Competition

Graduate student **Olugbenga Oluwatamilara "Tumi" Oredein Jr.** was named one of two grand prize winners in Walmart's "Get on the Shelf" contest for his SKRIBS Customizable Wristbands. SKRIBS received the second highest amount of pre-orders out of 1,600 entries.

"Tumi's innovative spirit perfectly captures the focus of the School of Engineering," said Dean Barbara D. Boyan, Ph.D. "Our students are collaborators, intuitive problem solvers and have the tenacity to see their invention come to life."

Oredein received his masters in Product Innovation last May.



Ph.D. Student Wins National Research Award

Lauren Griggs knew she wanted to work in medicine. While in high school, an "Introduction to Engineering" program at the University of Virginia led to an early fascination with biomedical engineering.

Now a Ph.D. student at VCU, Griggs works under Christopher Lemmon, Ph.D., assistant professor in the Department of Biomedical Engineering, where her research focuses on the spread of cancer.

Griggs presented her research at the Biomedical Engineering Society Annual Meeting and was one of only 20 recipients of the society's Innovation and Career Development Travel Award.

New Collaborative Facility Helps Turn Concepts Into Reality



The school's recently launched Translational Research Innovation Projects (TRIP) Facility, a new collaborative and prototyping venue, is designed to assist in moving research projects into prototype development toward commercialization.

"TRIP is designed to support faculty, graduate students and collaborators with multidisciplinary research tools and provide spaces to bring concepts through design and prototyping phases to a finished product," said associate dean for innovation and outreach L. Franklin Bost, MBA, IDSA, (pictured far right).

Located in BioTech One, adjacent to the VCU Medical Center, the 2,400-square-foot facility includes collaborative spaces for engineering and medical campus faculty to brainstorm design concepts, work on early stage prototypes and refine presentations. It is equipped with 3D rapid prototyping equipment, a machine-tooling center, a computer controlled lathe, laser cutter, standard shop tools and other equipment. The TRIP facility is part of the university's larger "Engineering for Healthcare" initiative of the VCU Institute for Engineering and Medicine.

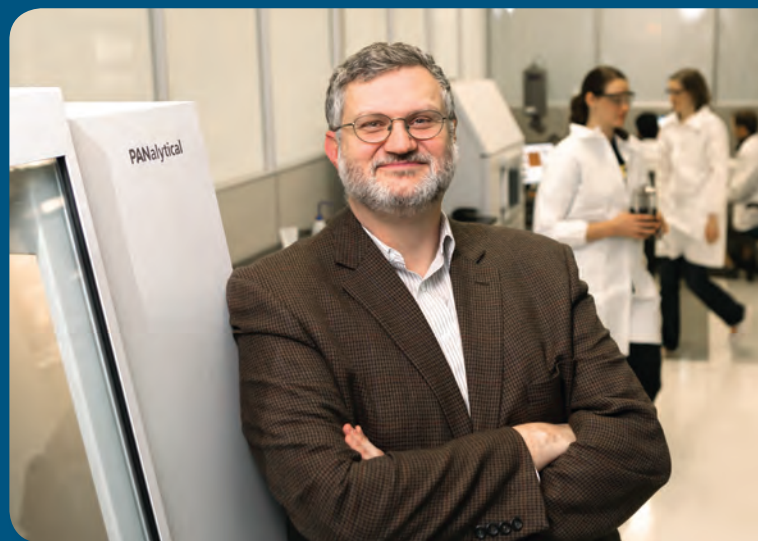
"TRIP provides spaces and tools to foster collaboration." – L. Franklin Bost, Ph.D.

High-Tech Instruments Now Available at Nanomaterials Facility

Need a Hitachi SU-70 FE-Scanning Electron Microscope to complete a research project? Or a Thermo ESCALab 250 Spectrometer? Look no further. Within the school's Institute for Engineering and Medicine is the answer to many scientists' dreams: access to high-tech microscopes, X-ray photoelectron spectrometers and other nano-scale equipment. These are just a few of the new tools available for use at the IEM's Nanomaterials Core Characterization Facility, one of the largest university-based research facilities in the country. Scientists, chemists, researchers, engineers and educators from industries and other research labs, as well as universitywide students and researchers can now characterize new materials or improve older ones with access to the equipment, which is available for rent by the hour.

"We have a complete suite of instruments that is unique to the region," said Everett Carpenter, Ph.D., (right), professor of chemistry and director of the Nanomaterials Core Characterization Facility. "Our staff and faculty have extensive experience with these instruments and can help with all characterization needs."

Contact Carpenter at (804) 828-7508 or visit www.nano.vcu.edu to learn about access to these instruments and more.



"The Nanomaterials Core Characterization Facility is one of the largest university-based research facilities in the country." – Everett Carpenter, Ph.D.



VIRGINIA COMMONWEALTH UNIVERSITY

VCU da Vinci Center



NAE Recognizes Unique Collaborative

The National Academy of Engineering selected the Virginia Commonwealth University da Vinci Center for Innovation as an outstanding academic program to be included in a report highlighting best practices for schools seeking to create new programs.

VCU was among 29 schools chosen from across the country, including Cornell, Duke and the Massachusetts Institute of Technology, to earn the distinction.

An original collaboration of the schools of the Arts, Business and Engineering, and the College of Humanities and Sciences, the VCU da Vinci Center is a unique collegiate model that advances interdisciplinary innovation and technology-based entrepreneurship.

Through academic and other program offerings, the da Vinci Center catalyzes innovation through the unity of arts, business and engineering principles as it prepares students to enter a product innovation career and supports learning initiatives by partner organizations.

"I am proud that the academy recognized the da Vinci Center for the real-world opportunities it provides students and their clients and because of the unique research opportunities that are afforded by the collaboration among the engineering, arts and business disciplines," said VCU President Michael Rao, Ph.D.

The best practices outlined in the report include incorporating multidisciplinary team-based projects into curricula to help students develop skills in decision-making, leadership, written and oral communication, organization and time management, cultural awareness and problem solving.

"This recognition is a great honor, and affirms the unique value and importance that innovation through interdisciplinary collaboration has for today's work environment," added Kenneth Kahn, Ph.D., professor of marketing in the School of Business and director of the da Vinci Center. "This honor also affirms the vision and hard work of the administrators, faculty and staff who supported the creation of the VCU da Vinci Center and who are helping to grow our programs towards national and international prominence."

Ninety-five nominations were reviewed by the committee and judged based on seven factors: program creativity, innovation, attention to diversity (including geographic, institution, racial/ethnic and gender), sustainability plan, assessment of student learning, level of real-world experience and anticipated versus actual outcomes.

"These types of collaborations are key to a national research university's increasing role in shaping our future in a progressive society."

–VCU President Michael Rao, Ph.D.

Women In Engineering: Setting An Example



United States engineering schools and colleges in the percentage of engineering master's degrees awarded to women, nearly double the national average.

The encouragement of women in engineering starts at the top: Barbara D. Boyan, Ph.D., was named dean of the school in 2013. "VCU is about breaking barriers and leading the field in diversity," says Boyan. "If you were a young woman in my office I would say to you 'the sky is the limit, get moving, come to VCU, become an engineer.' "In 2012, nearly half of all master's degrees were awarded to women.

The School of Engineering is all about making breakthroughs. From scientific breakthroughs to breaking down barriers for all who wish to learn. When it comes to women in engineering, the school leads by example. It has established itself as a prolific producer of female engineers, in a field traditionally underrepresented by women. In fact, in 2011, the American Society of Engineering Education ranked VCU first among all



Faculty Awards



Yuichi Motai, Ph.D., assistant professor of electrical and computer engineering, has been elevated to senior member of the Institute of Electrical and Electronics Engineers. The senior membership is the highest professional level in the organization. The IEEE is the world's largest professional association for the advancement of technology. Only 8 percent of its 416,000 members have achieved the elite senior member level.



Jayasimha Atulasimha, Ph.D., associate professor of mechanical and nuclear engineering, has been awarded a five-year National Science Foundation Faculty Career Development (CAREER) award, one of the foundation's most prestigious awards. The CAREER awards are presented to support junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations.



Preetam Ghosh, Ph.D., assistant professor of computer science, has been awarded a two-year \$100,000 Early Concept Grant for Exploratory Research from the National Science Foundation for his research, "Exploring Biological Networks Robustness using Bio-Inspired Wireless Sensor Networks: A Novel Paradigm for Systems Research."

Alumni Set to Help Shape the Future

The School of Engineering Foundation welcomed alumnus Jason Roe '01 to its board last October. Roe is the first alum to serve under the Foundation's new "Alumni Integration Program," where every year a new member of the alumni body is asked to serve a single three-year term. Roe '01 joins fellow alum Brad Crosby '01, a board member since 2006. The "Alumni Integration Program" gives us a chance to immerse future board candidates into the life of the Foundation so they have a better understanding of the Board's role in advancing the School of Engineering" explains R. Scott Rash, the Foundation's executive director and chief development officer.

Founded in May 1995, the School of Engineering Foundation supports programming to enhance the educational experience of the student body. Organized exclusively for educational, scientific, and charitable purposes, the Foundation provides guidance and financial support for the school's physical infrastructure, scholarships, professorships, chairs, and academic programming. Other ongoing initiatives include support of student organizations, the Career and Tutoring Centers, co-curricular programming, the Capstone Design Expo, and community engagement events.

"Involving alumni in the strategic and development work of the alumni and Foundation boards," Rash says, "helps bridge the gap between industry and those at the pulse of the student experience." Both boards work hard to keep the VCU School of Engineering, the engineering profession, and STEM careers, at the forefront of community engagement and university pride.



Jason Roe (BS'01)
Cum Laude, Electrical Engineering



R. Scott Rash
Executive Director, Chief Development Officer
VCU School of Engineering Foundation



*"VCU's engineering students are doing good work and they're enthusiastic."
—Joseph W. Roos, Ph.D., Afton Chemical Corporation*

Capstone Senior Design Expo: *Bringing Industry and Students Together*

Road-adaptive headlights? Automated shower devices for those with limited mobility? Life-enhancing products like these may not be far off thanks to the annual Senior Design Expo.

Senior VCU engineering students, working across the school's collaborative programs along with their faculty advisers, spend their final undergraduate year conceptualizing, designing and testing projects aimed at improving human life and advancing technology and research. The exercise brings them together with industry innovators who serve as judges or advisers.

Held annually in April, the event offers teams the opportunity to display and demonstrate their prototypes. On average, between 35 and 40 student teams participate in what has become a signature

event for the School of Engineering as well as VCU.

"People from the engineering industry interview our students at the Senior Design Expo and are always impressed by the project presentations," said Afroditi V. Filippas, Ph.D., interim associate dean for undergraduate studies, associate professor, Department of Electrical and Computer Engineering, and Design Expo coordinator. "Some of our industry partners are taken aback at the level of innovative thinking and work ethics that our students bring to the table."

Judges from business and industry have included representatives from Amazon, DuPont Teijin Films, Evonik Goldschmidt, Flexicell, Honeywell, GE Cybersecurity, Micron Technology, Old Dominion Electric Cooperative and United Equipment

Corporation. Some of these companies and others also provide grant funds, equipment and industry advisers to assist the student teams.

"We do projects with VCU and have engineering students who work with us. We also have staff members who come to VCU for graduate work," said Joseph W. Roos, Ph.D., an expo judge and Technical Director for Technology Development at Afton Chemical Corporation. "VCU's engineering students are doing good work and they're enthusiastic."

The expo, co-sponsored by the Science Museum of Virginia, sees more than a thousand middle and high school students come through each year where they get a firsthand view of how their education could lead to college-level engineering studies and future STEM and health care careers where demand for skilled employees is high.

Grants provide real-world experience

Like many engineering seniors, Dimitri Karles (B.S. '12) and his teammates were faced with a dilemma when preparing their capstone project: how to pay for it.

Senior design projects are a graduation requirement. The program is designed to teach leadership skills, to foster collaboration and to provide a glimpse of product innovations that could one day benefit society at large. The student teams typically fund construction of their project prototypes themselves. Previous teams have designed everything from human-powered moon buggies and home security systems to drug-delivery devices and solar-powered water filtration systems.

Things looked up for Karles and his teammates, Laura Deal (B.S. '12) and Andrea Elkovich (B.S. '12), when they learned about the new Mark A. Sternheimer Senior Design Award. Established in 2011 by long-time School of Engineering benefactor and Engineering Foundation Board member Mark Sternheimer, the Sternheimer Senior Design Award provides, through a competitive grant process, up to \$10,000 annually for three years to support senior design project development and fabrication.

Karles and his team applied for an inaugural grant and received full funding for their innovative evaluative eye-tracking system. In all, 31 teams applied and 14 won awards. Award amounts varied and were based upon the teams' budget requirements. Judging criteria included the completeness of the grant application as well as project creativity.

"The student grant applications included submission of an abstract and a complete project budget," said R. Scott Rash, CFRE, executive director



Dimitri Karles (B.S. '12)

and chief development officer for the School of Engineering Foundation.

The real-world experience of grant writing and detailed budgeting required by the Sternheimer Award program, Rash explained, helped students focus on what was needed to turn their planned projects into reality.

"From scholarships to research on unmanned aerial vehicles, Mr. Sternheimer has invested in student-centered initiatives within the School of Engineering since its inception. His commitment to funding senior design projects through this grant process over the next three years is a great example of how a donor can leverage philanthropy in support of student's co-curricular opportunities. In this case the students, win or lose, got an opportunity to go through a competitive grant process while key corporate friends of the School of Engineering got an in-depth, first-hand look at the quality of students the school is educating."

"From scholarships to research on unmanned aerial vehicles, Mr. Sternheimer has invested in student-centered initiatives within the School of Engineering since its inception.

—R. Scott Rash, CFRE, executive director and chief development officer, School of Engineering Foundation

The Virginia Commonwealth University School of Engineering's growth strategy over the next five years includes unprecedented faculty recruitment and retention efforts. Why? So that our students get the very best instruction and the most meaningful real-world experience possible. The future holds a school size double that of today as well as further opportunities for universitywide collaborative engagement for both students and faculty. It is with this dynamic future in mind that we applaud our talented and visionary faculty where they make it real for our students every day.

OFFICE OF THE DEAN

Barbara D. Boyan, Ph.D. 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
- Normal and pathological calcification

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Research Topics:

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- Medical applications
- Semi-real-time algorithms
- Performance evaluation
- Graphics
- Database and networks

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- Device Design and Development Processes
- Entrepreneurial Business Strategy and Development
- US FDA Quality System Regulations and ISO Medical Device Standards

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- Numerical analysis techniques and software

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- Signal processing and nonlinear statistical analysis techniques

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- Database design
- Fuzzy database
- Missing Information in relational database

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Research Topics:

- Bone Cartilage and mineralization and their relation to Vitamin D, sex hormones and local factors.
- Periodontal diseases, etiology and treatment
- The Effect of Vitamin D on Cartilage Cells in Vitro
- The Effect of Sex Hormones on Endochondral Bone Formation
- Role and Development of Bone Substitutes
- Surface Characteristics in Implant Success

BIOMEDICAL

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Research Topics:

- Rehabilitation engineering-analysis and design of devices to aid the disabled
- Man-machine interfacing-analysis and design of voice-recognition systems
- Artificial hearts-analysis and design of a multiple disk centrifugal blood pump

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Research Topics:

- Algorithms and systems development of brain-computer interface
- Human motor control physiology
- Development of brain-computer interface-based device for patients with movement disorders
- System development of imagery-based motor learning for stroke rehabilitation
- Development of algorithms and graphic-user interface for investigation brain neuronal connectivity
- Development of algorithms and systems for computer-aided diagnosis
- Algorithm development of neurophysiological signal processing and classification
- Multimodal functional neural imaging

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Professor and Alice T. and William H. Goodwin, Jr.
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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
- Normal and pathological calcification

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- Live-cell imaging
- Cellular biomechanics
- Forces at intracellular junctions

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- Bioinstrumentation
- Telemedicine
- Magnetic resonance imaging (MRI) techniques for studies of vessel properties and vascular hemodynamics
- Ultrasonic imaging techniques for studies of cardiovascular dynamics
- Technologies for radiation oncology

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Research Topics:

- Pulmonary mechanobiology
- Tissue engineering
- Smooth muscle cell signaling
- Cellular biomechanics

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- Innovation and entrepreneurship
- Leadership of teams in ambiguity
- K-12 STEM education
- Bioregeneration
- Tissue engineering

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- Extracellular matrix biology
- Cellular traction forces
- Cell mechanosensing
- Tissue engineering

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Research Topics:

- Non-invasive cerebral spinal fluid pressure device
- High noise speech communication system (Northrop Grumman Inc.)
- Baby echolocator a device to allow deaf babies to "see" acoustically facilitating perceptual motor development. (NIH)
- Military echolocator (DHS)
- Baby multimodal (bone conduction and vibrotactile) hearing aid using algorithms to track mother's voice
- Tinnitus (phantom sound perception) management system using high frequency stimulation and custom actuator (US ARMY)

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- Surface Modifications for Dental and Orthopedic Implants
- WNT Signaling
- Mesenchymal Stem Cell and Biomaterials Interaction
- Osteoblast Differentiation and Maturation in Biomaterials
- Limb Regeneration
- Growth Factors in Bone Development and Regeneration

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Research Topics:

- Haptic displays for blind and visually impaired individuals
- Human factors analysis during minimally invasive surgery
- Haptic technology for engineering education
- Haptic devices for rehabilitation
- Tissue modeling for surgical stimulators

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Research Topics:

- Image analysis – use of high-frequency ultrasound to investigate wound healing
- Image segmentation – analysis of pressure mapping systems to investigate development of pressure ulcers
- Health informatics – analysis and design of decision tools for the coordination of care of older adults

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Research Topics:

- Bone Cartilage and mineralization and their relation to Vitamin D, sex hormones and local factors.
- Periodontal diseases, etiology and treatment
- The Effect of Vitamin D on Cartilage Cells in Vitro
- The Effect of Sex Hormones on Endochondral Bone Formation
- Role and Development of Bone Substitutes
- Surface Characteristics in Implant Success

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Research Topics:

- Experimental and computational modeling of diarthropal joint function
- Structural performance of fixation constructs
- Articular Cartilage: normal function, reparative techniques, tissue engineering

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Research Topics:

- Eye tracking systems and eye movement analysis
- Effects of neurological diseases on eye movement control
- Visual task analysis
- Physiological instrumentation and signal processing systems
- Human-machine interfaces based on eye and head movement

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Research Topics:

- Biomaterials
- Cancer research
- Dendrimer
- Drug Delivery
- Gene therapy
- Nanoparticles
- Nanoscience and nanotechnology
- Smart polymeric materials and structures
- Tissue engineering

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Research Topics:

- Behavior and plasticity of stem cells
- Interactions of stem cells with microenvironments
- Clinically applicable stem cell therapy and translational stem cell research
- Stem cells and cancer
- Nanotechnology

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Research Topics:

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

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Research Topics:

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- Synthetic biology
- Evolutionary biology
- Metabolic engineering
- Computational modeling

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Research Topics:

- Statistical signal processing and communications
- Data fusion and distributed signal processing in sensor networks
- Detection, estimation, and tracking
- Dynamic resource management in networked systems
- MIMO radar networks
- Compressive sensing

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Research Topics:

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- Nonlinear optics
- Ultrafast spectroscopy
- Near-field optical microscopy
- Nanophotonics

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Research Topics:

- Programming languages
- Compiler design
- Automatic generation of software

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Research Topics:

- Cascading failures in power grids
- Energy system modeling and optimization,
- Integration of renewable generation
- Voltage stability and controls
- Smart Grid Communication Architecture

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- High-performance and GPU computing
- Emerging storage and memory technologies
- Embedded system
- Computer architecture

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Research Topics:

- Real-time and embedded systems
- Worst-case execution time (WCET) analysis
- Computer architecture and compiler
- Low-power computing

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Research Topics:

- Chemical sensors
- Nanomaterials
- Radiation detectors
- Functional coatings
- Electroprocessing of polymers

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Research Topics:

- Hybrid spintronics-straintronics for ultralow power memory, logic and higher order information processing
- Nanomagnetism: Nanoscale magnetization dynamics
- Spintronics: Spin transport and manipulation in nanowires

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Research Topics:

- Experimental and computational thermal-hydraulics, two-phase flow and heat transfer for nuclear applications, including the development and verification of suitable thermal-hydraulic and heat transfer correlations
- Modeling of advanced nuclear systems and applications with subchannel, system and computational fluid dynamics (CFD) codes
- Design of advanced nuclear power plant concepts that rely on sophisticated thermal-hydraulic phenomena (e.g., natural circulation, supercritical water systems, molten salt systems, liquid metal systems)
- Nuclear safety and severe accidents
- Energy and environmental policy, energy planning and nuclear infrastructure development, in support of emerging and expanding nuclear programs
- Public perception, as well as education, communication and outreach in the area of nuclear science and technology.

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Research Topics:

- Device Design and Development Processes
- Entrepreneurial Business Strategy and Development
- US FDA Quality System Regulations and ISO Medical Device Standards

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Research Topics:

- Design Engineering
- Design Optimization
- Engineering Education
- Fuel Cell and Hybrid Technology
- Manufacturing Engineering
- Material Engineering
- MEMs Technology and Devices
- Rapid Prototyping Processes
- Solid Mechanics

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Research Topics:

- Nanoparticles and Nanotechnology
- Powder and spray technology
- Particle instrumentation and characterization
- Particle coating, charging, fluidization and transport
- Filtration and separation
- Air pollution and indoor air quality control
- Drug target delivery and release control
- Synthesis of functional particles for pharmaceutical and biomedical applications
- Health effect and toxicity of particles
- Multiphase chemical reacting flow and reactors
- Micro-contamination control in semiconductor manufacture processes
- Atmospheric aerosol

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Research Topics:

- Fluids in motion
- Flow control
- Viscous pumps and microturbines
- Micro-and nanotechnology
- Large-Scale Disasters

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Research Topics:

- Engineering education
- Process control engineering
- Manufacturing engineering
- Total quality management

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Research Topics:

- Respiratory drug delivery and inhalers
- Nanoaerosols
- Targeted drug delivery systems
- Multiphysics modeling
- Respiratory gas delivery

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Research Topics:

- Photovoltaic materials and devices
- Power generation
- Energy conversion systems
- Engineering education
- Optical characterization of semiconductor materials

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Research Topics:

- Electrical and mechanical characterization of smart materials and their applications in aerospace, automotive, medical, and electrical fields
- Materials and their response to different environments and the variation of their properties under different temperatures and boundary conditions (fluid mechanics, controls, equivalent circuits, mechanic of materials)
- Energy scavenging using pyroelectric and piezoelectric materials for low-power electronics

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Research Topics:

- Response dynamics and vibrations of offshore drilling and production systems and equipment arising from various sources of excitation (wind, waves, currents, seafloor soil conditions, fluids, pressure, thermal, floating platform motions)
- Deepwater marine riser systems and the various nonlinear effects arising from the six degree-of-freedom motions of ships and floating platforms, vortex-induced vibrations, axial dynamics, and three-dimensional nonlinear interactions of the riser systems
- Simulation and control of sophisticated, high-capacity tensioning systems with mechanical, fluid, and thermal transients and floating platform motions are examined by computational methods for operational situations

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Research Topics:

- Design and Development of high resolution neutron, gamma and X-ray computed tomography system for industrial and medical applications
- Development of novel algorithms for radiation imaging systems and their performance evaluation
- Radiation detection, measurements and imaging techniques for explosive detection, homeland security applications and nuclear security research
- Radiation protection and dosimetry
- Production of radionuclides for diagnostic and therapeutic purposes

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- Smooth muscle biomechanics
- Developing robotic devices for medical applications

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Research Topics:

- Nanoelectromechanical systems (NEMS)
- Electrokinetic nanoengineering
- Nanomaterials
- Nanofabrication
- Advanced microscopy
- Nanomechanics
- Small-scale energy storage/harvesting/generation

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Research Topics:

- Superhydrophobic surfaces and interfacial phenomena
- Multi-phase fluid transport in fibrous porous media
- Aerosol flows and nanoparticle filtration
- Heat and mass transfer in porous media
- High-speed jets and nozzle design
- Molecular dynamics simulation

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Research Topics:

- Actinide bearing ceramic nuclear fuel
- Nuclear structural materials
- High temperature materials processing and mechanical testing
- High temperature irradiation behavior of ceramics including mechanical properties and microstructural changes
- Materials-coolant interaction
- High temperature deformation mechanism maps
- Neural networks for probabilistic risk assessment
- Design of nuclear materials irradiation experiments
- Nanofluids for reactor applications
- Computational methods in nuclear reactor physics and advanced nuclear reactor design

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- Electrochemical processes--theoretical and experimental studies in electrorefinery, electrolytic oxide reduction and chemistry, and ion exchange
- Special material detection and analysis via laser and mass spectroscopy techniques
- Interfacial phenomena and multi-phase flow systems involving in nuclear and chemical engineering applications

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- Multi-Scale Diagnostics and Therapeutics
- Bio-interfaced Nanoengineering (Nanomechanics)
- Soft Material-based Stretchable Electronics
- Nanostructured Biosensing

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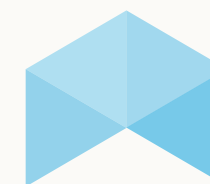
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Published by:
Virginia Commonwealth University School of Engineering
P.O. Box 843068 | Richmond, Virginia 23284-3068
Phone: (804) 828-3925 | www.egr.vcu.edu

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