COLLEGE OF ENGINEERING AND MATHEMATICAL SCIENCES

SUMMIT

FALL ISSUE 2016

Biomedical Engineering

UVM College of Engineering and Mathematical Sciences Partners with UVM Larner College of Medicine

UNIVERSITY OF VERMONT

The Dean's View

CEMS Leadership in front of the Barrett Bridge of the new STEM Complex. (From left) Interim Chair of Electrical and Biomedical Engineering Jeff Frolik; Associate Dean for Faculty Affairs Christian Skalka; Interim Chair of Mechanical Engineering Yves Dubief; Chair of Computer Science Maggie Eppstein; Dean and Barrett Foundation Professor Luis Garcia; Interim Chair of Civil and Environmental Engineering Mandar Dewoolkar; Chair of Mathematics and Statistics Jeff Buzas.

As I start the fourth year of my tenure as Dean, I am humbled to see how much we have accomplished as a team. Three years ago, with the help of faculty, staff, alumni and students we began to imagine, design and build a fabulous future for CEMS, and as a result of our collective efforts, we are now realizing that future. Over the last three years we have seen the following:

- The largest investment in infrastructure in the College's history (not only the $104M STEM complex, but also substantial investments to improve our teaching labs, lab equipment, offices, and common areas.)
- Last year we had our best ABET accreditation visit in the College history.
- We have restructured the School of Engineering into individual departments starting July 1st of this year.
- We have received approval for three new degree programs (B.S. in Data Science, B.S. in Biomedical Engineering, and M.S. in Complex Systems and Data Science). In addition we are working on proposals for two new M.S. degrees (Biomedical Engineering and Engineering Management).
- This fall we welcomed the freshman class with the highest SAT scores, while over the last three years we have increased selectivity by 10% and have increased the incoming class by 19%.
- We have increased the female student population in the College by over 17%.
- We have more than doubled our staff in the Office of Student Services which has allowed us to increase the support for our students, including internship opportunities as well as a new co-op program.
- With your support, we have raised more than 86% of the $11M capital campaign goal for the College.

I look forward to highlighting a number of other accomplishments and opportunities in future issues of Summit. In the meantime please check out our much improved website and social media for more frequent updates.

Sincerely,

Luis Garcia, Ph.D.
Dean and Barrett Foundation Professor
College of Engineering and Mathematical Sciences

Photo: Sally McCay


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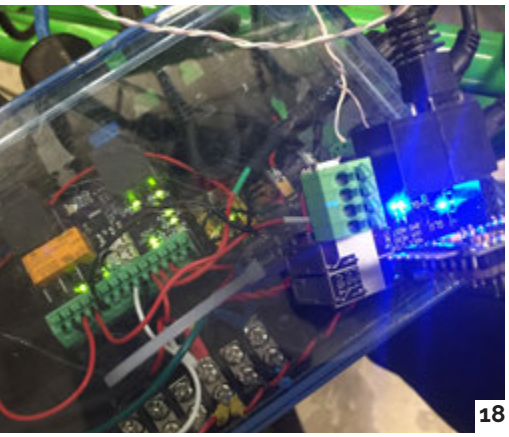
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SEND LETTERS AND ALUMNI NEWS TO:
summit@uvm.edu

ON THE COVER:
Sophomore Kiki Cunningham in Professor Rachael Oldinski's lab. Photo: David Seaver

Two New Majors Added to STEM Curriculum

There are currently only 50 institutions with a Biomedical Engineering program that offers an accredited degree as well as a Medical School that grants MD degrees and UVM is eager to join this elite group.

This February saw the approval of two new bachelor of science programs — biomedical engineering and data science — at the College of Engineering and Mathematical Sciences (CEMS). The new programs support UVM's efforts to expand STEM education with a goal of doubling enrollments in STEM-related programs by 2020. The programs will be housed in the new $104 million STEM complex of new and renovated laboratories, classrooms and research facilities scheduled for completion in May of 2019.

The proximity of CEMS to the Larner College of Medicine is expected to provide high quality partnerships for the biomedical engineering program.

"The approval of the bachelor's degree in biomedical engineering is great news for UVM students," said Luis Garcia, Ph.D., dean of CEMS. "This area of interdisciplinary study will promote collaborative education between the outstanding engineering faculty and the research colleagues in the highly ranked Larner College of Medicine. This is a unique opportunity that will allow us to leverage the teaching, research and clinically-related facilities to provide a world-class learning environment for our students."

The Bachelor of Science degree in data science was created to prepare students for careers in the rapidly growing field of big data science and analytics. The demand for data scientists is among the highest of any job sector in the U.S. due to a growing need by employers for individuals who can analyze large, highly complex data sets. Data scientists are increasingly in demand across a spectrum of occupations including government, finance, business, and journalism to name a few.

In becoming the only flagship university in New England — and just one of four in the Northeast — to offer students an education in this field accredited by the New England Association of Schools and Colleges (NEASC), UVM is well positioned to meet the needs of this emerging sector. UVM is expected to draw students interested in greater access to already-established scholars in the field and related disciplines.

"I am delighted by the Board of Trustees' approval of the bachelor's degree in data science," said Garcia. "This degree combines the disciplines of computer science, mathematics and statistics, which are critical skill areas for today's societal needs, and will allow us to prepare students for careers in big data and analytics. These are areas with huge demand, which align with the state-of-the-art research conducted by our faculty."

STEM UPDATE

IN MAY OF 2015, UVM BROKE GROUND FOR THE NEW SCIENCE TECHNOLOGY ENGINEERING AND MATHEMATICS (STEM) COMPLEX.

David Rosowsky, provost and senior vice president of UVM, described the project to the University's Board of Trustees:

"STEM is the collection of academic disciplines that has been associated with the most promising economic development opportunities, finding solutions to the grand challenges we face as a nation, a planet, and a people…

So critical are STEM graduates to the future of our nation that President Obama has called for 10,000 new STEM graduates every year. Here in Vermont, Governor Shumlin has called for significant growth in the number of STEM graduates to fill jobs in the state, to help attract new companies to Vermont with the promise of talented and well-educated university graduates, and to create new technologies and companies that will create new jobs in the state."

As such, a new STEM complex was identified as the highest priority facility in UVM's Capital Plan. The University is constructing a state-of-the-art laboratory, classroom, and office complex to accommodate modern teaching and research needs.

The campus has been busy with phases over a four year period. The first phase is construction of the Discovery Building, a cutting-edge teaching and research facility; the second is the Innovation Building, a classroom/office facility; the third phase consists of constructions and renovations within Votey Hall.

The UVM STEM complex construction site in August 2016.

STEM BY THE NUMBERS

$26M

CAMPAIGN GOAL FOR THE STEM COMPLEX

VOTEY RENOVATION HIGHLIGHTS

2016

- Roof Replacement, including a renovated rooftop research area.
- Bridge connection from Votey to the first STEM building, Discovery.
- Stairwells renovated.

2017

- Fluid and Hydraulics Labs will be merged into a new 1500 sq. ft. Hydraulics Lab.
- CEMS Prototyping and Machine Shop will expand to 2400 sq. ft. and will feature equipment upgrades.
- Soils Teaching Lab will be equipped with a Darwin Curing Chamber and relocated to a 1500 sq. ft.
- A new Senior Design Project Lab, 1200 sq. ft.
- A new CEMS Student Club Space, 1000 sq. ft.
- CEMS FabLab will relocate to a 1000 sq. ft. space.
- A new Biomedical Engineering lab, 1200 sq. ft.
- On the third floor, 5000 sq. ft. of Electrical and Biomedical Engineering labs will be renovated.

FOLLOW THE STEM PROJECT

WWW.UVM.EDU/~ARCH/

Photo: Ed Neuert

2016-2017 Internships

BY JESS CLARKE

Many students in the College of Engineering and Mathematical Sciences gain valuable real-world experience in settings across the U.S. during their summer breaks and throughout the academic year.

CHARLES NORTON III & ELI KRAVITZ

Charles Norton III and Eli Kravitz, both senior Mechanical Engineering students, are completing a year-long Co-Op with Husky Injection Molding Systems Inc. at their manufacturing facility in Milton, Vt. Each have a variety of tasks in Development Engineering including testing, reverse engineering, failure analysis, data processing, and reporting oral and written results to team members.

COLE HANSON

Cole Hanson, a junior Mechanical Engineering major, spent the summer at CHC Helicopter in Irving, Texas as the Aircraft Reliability and Health Usage Analyst Intern. CHC provides helicopter services predominantly to offshore oil and gas rigs, transporting people and materials to and from.

Over the summer Cole built presentations to pitch to executives, compiled a main database containing every aircraft and determined the range capability of each helicopter. Cole says, "I haven't had one major project but many different ones. Taking an internship with CHC Helicopter has been a very rewarding experience and has allowed me to sample how a global corporation functions, opening my eyes to an industry I didn't even know existed at the beginning of this summer."

Emily Bolt - CE '17, Civil Engineering Intern at City of Burlington Department of Public Works

Interns at Hayward Tyler in Colchester, Vermont
(Left to right) Benedict (Ben) Delahunty - ME '17 and Jake Fragnoli - ME '17, Service Value Stream Interns.
Abby Taylor - ME '17 and Daniel Russell - ME '18, Engineering Interns

CEMS BY THE NUMBERS

100%

SUMMER 2016 INTERNSHIP EMPLOYERS REPORTED THAT OUR INTERNS ACHIEVED ALL LEARNING OUTCOMES AND COMPLETED ALL ASSIGNED TASKS AND PROJECTS.

Students can meet with the CEMS Career Readiness Program Coordinator, Lauren Petrie, or any Career Counselor in the UVM Career Center for help finding jobs or internships. More information can be found on the Career Resources and Experiential Learning page on the CEMS website.

2016 AWARDS

Edward Haight Phelps Prize
Andrea J. Elhajj

Douglas P. Fay Award
Tyler William Kuehl

Senior Award for Computer Science
Ariel James Larson

Atwater-Kent Award
Elena Melloni and Nathaniel Bronson Rex

Mathematics Senior Award
Azulena M. Royer

Statistics Undergraduate Achievement Award
Rachel Meredith Heiser

Edmund F. Little Award
Lianna Nicole Altieri

Mechanical Engineering Undergraduate Research Award
Nicholas Charles Martin

Mechanical Engineering Undergraduate Service Award
Lydia Jean Hanstsche

Engineering Management Senior Award
Mathew Edward Fraser

American Society of Civil Engineers Award
Jamie Francis Martell

Engineers Without Borders Award
Benjamin Arthur Cares

IEEE Society Award

Tau Beta Pi Society Award

Society of Women Engineers Award (co-recipient)
Ann-Linea A. Towle

Society of Women Engineers Award (co-recipient)
Megan Elizabeth Yeigh

Vermont Society of Professional Engineers Award
2016 Student Engineer of the Year
Anna-Linea A. Towle

Dean's Recognition Award
Taylor David Ducharme

Photos: CHC Helicopter, Andy Duback

RECENT RETIREMENTS

KEN GROSS, PH.D.

The College celebrates the rich career of Professor Ken Gross, who retired this summer. Among his many accomplishments are the co-founding of the Vermont State Mathematics Coalition, and the Vermont High School Summer Mathematics Institute, and his founding of the Vermont Mathematics Initiative to improve mathematics education in grades K-12. He has published 40 papers, edited three books, and his work was widely supported by grants from the National Science Foundation and the U.S. Department of Education. For nearly three decades at UVM, and five decades as a university faculty member, Professor Gross has left a lasting legacy and has made a strong impact on all those who worked with him.

STEVE TITCOMB, PH.D.

Steve Titcomb has always held the responsibility for teaching the next generation of Electrical Engineering professionals above all else. He has prepared and taught the material for 30 different courses in engineering at UVM. At one time, in a single semester, Dr. Titcomb taught a collection of courses which served every EE major on the UVM campus. He is credited with creating a laboratory sequence for all six Electrical Circuits courses taught at UVM. Dr. Titcomb earned his doctorate in physics from Lehigh University, where he investigated the electrical properties of the Metal-Oxide System in Silicon. He joined the faculty in 1983, and served as Department Chair and Program Director. He received the dean's award In Recognition of Outstanding Service in 2015.

Ken Gross at the UVM Graduation Ceremony in 2002 when the first cohort of VMI graduates received their master's degrees.

Ken Golden with Steve Titcomb and Provost David Rosowsky at the 2016 CEMS Commencement Ceremony.

KEN GOLDEN, PH.D.

Ken Golden joined the faculty in 1986 as chair of the Department of Computer Science and Electrical Engineering. Over these past 30 years, his dedication to research, and kindness to all, have been an inspiration to colleagues and students. In 1994 he joined the Department of Mathematics and Statistics, and from 2007 to 2012 was the Williams Professor of Mathematics. He was honored as a University Scholar in 1992 and as a Distinguished Professor in the College of Engineering and Mathematical Sciences in 2005. He was in the Departments of Physics and Electrical Engineering for much of his career at UVM. Ken earned his doctoral degree in theoretical mechanics at the Institute Henri Poincaré in Paris and holds two endowed professorships at Northeastern University. He has written over 100 refereed publications in top-tier journals and received numerous national and international awards, including being named a Senior Fellow of the American Physical Society, Fellow of both the British and Australian Institutes of Physics, and Fulbright Senior Scholar

Accelerated Master's Program Takes Off

CEMS BY THE NUMBERS

29.7%

OF CEMS UNDERGRADUATES ARE VERMONTERS

Baxter Miatke and Matt Brand, both of whom received their undergraduate degrees from CEMS in 2015, became the first UVM Environmental Engineering graduates since the degree's inception in the mid-2000s to complete the Accelerated Master's Program in Civil and Environmental Engineering with a thesis in just one additional year.

Baxter's thesis was titled *A Framework for Optimizing the Temporal Variability in River Nutrient and Sediment Load Estimates*. He is now working as a Staff Engineer at the Johnson Company in Montpelier, Vt., focusing on environmental engineering and remediation. Matt's thesis was titled *Use of Sacrificial Embankments to Minimize Bridge Scour Damage in Extreme Flow Events*. After completing his graduate degree, Matt drove across the country to begin his Ph.D. program at the University of California-Irvine, where he is focusing on hydrology and climate change.

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Photos: Sally McCay, GradImages

UVM Helps Create a New Map of Mathematical Objects

Assistant Professor Christelle Vincent is part of a twelve-nation team expanding the frontiers of mathematics.

BY JOSHUA BROWN

An international group of mathematicians, including two researchers at the University of Vermont, has released a new kind of mathematical tool: an online atlas that provides detailed maps of previously uncharted mathematical terrain.

The "L-functions and Modular Forms Database," or LMFDB, exposes deep relationships and provides a guide to new mathematical landscapes that underlie current research in several branches of science, including quantum physics, computer science, and cryptography.

"It's a massive collaborative effort involving over 100 mathematicians from around the world," said Christelle Vincent, an assistant professor of mathematics at UVM who has been working on the new atlas over many months. "It's both beautiful and functional, shining light on surprising and profound relationships in the abstract universe of mathematics."

A staggering amount of computational effort went into creating the LMFDB: about a thousand years of computer time spent on calculations by multiple teams of researchers. Many of these calculations are so intricate that only a handful of experts can do them, and some computations are so big that it makes sense to only do them once.

For Vincent, the new LMFDB database is "like a museum with all of our best specimens," she said. "You can find rare and hard-to-produce items there—that can let a researcher or student study something they didn't know existed or that would be impossible to reproduce on their own."

The new project is also a bit like "the first periodic table of elements," Vincent notes. The team, supported by the National Science Foundation and others, has been able to find enough of the building blocks that "we can begin to see tantalizing structures and find surprising and intriguing relationships," she said.

Dr. Vincent and Taylor Dupuy, both members of the Department of Mathematics and Statistics at UVM, have been deeply focused on this new database effort over the last year. "As an avid user of the LMFDB in my own research I felt that it was incumbent on me to help out in whatever way I could to make the database accessible to others," Vincent said.

NEW HIRES AT CEMS

1 Nichole Caisse
LECTURER, MATHEMATICS
Nichole received both a master's in mathematics education and master of science in mathematics from UVM. She began teaching here in the Fall of 2015. "I am deeply committed to working with students to help them understand the process of problem solving," she says. Her research has covered topics such as fluid dynamics and the effectiveness of arts integration in the Mathematics classroom.

2 Lisa Dion
LECTURER, COMPUTER SCIENCE
Lisa comes to CEMS from the University of Michigan, where she earned a master's degree in computer science and served as a graduate student lecturer. Her areas of expertise include C++, Python, Java and Git. She participated in research at Alcatel-Lucent Bell Labs and at General Dynamics Electric Boat. She's also served as an instructor for *Girls Who Code*.

3 Maryam Etezad
LECTURER, ELECTRICAL ENGINEERING
Maryam was most recently a senior research scientist at Northern Radar, Inc. She has taught at Memorial University in St. John's, Newfoundland, and at Concordia University in Montreal. She has a B.S. degree in applied physics from Shahid Beheshti Univeristy in Tehran, and an M.S. degree in electrical engineering from Concordia University, where she also earned her Ph.D. in electrical engineering.

4 Luis Duffaut Espinosa
RESEARCH ASSISTANT PROFESSOR, ELECTRICAL ENGINEERING
Luis holds a Ph.D. in electrical and computer engineering from Old Dominion University, an M.Sc. in mathematics from Pontificia Universidad Católica del Perú, and B.Sc. in physics from the Universidad Nacional de Ingeneria in Perú. He was a postdoctoral fellow at Old Dominion and Johns Hopkins Universities, as well as a research associate at the University of New South Wales, Australia. He then joined the faculty of George Mason University until the spring of 2016. His research includes control and modeling of nonlinear systems, stochastic processes and algebraic combinatorics.

Photos: David Seaver and Sally McCay

5 Jacob Martin
LECTURER, STATISTICS
Jacob comes to UVM from the University of Georgia, Athens where he earned a Ph.D. in statistics. His dissertation topic was *Topics in Zero-inflated Poisson Regression: Coefficients of Determination and Marginalized Models.* While at Georgia he was an instructor of Introductory Statistics and Computing, Statistical Methods and Honors Applied Statistics. As a graduate student he received awards for teaching and academics.

6 Ryan McGinnis
LECTURER, BIOMEDICAL ENGINEERING
Ryan received a Ph.D. in mechanical engineering from the University of Michigan, where he also completed a post-doctoral fellowship in kinesiology. He previously worked as a senior algorithms engineer at MC10, Inc., has been an instructor for a Nature of Engineering Materials course at Lafayette College, has published numerous peer-reviewed journal articles on human biomechanics, and is an inventor on a number of patents.

7 Hamid Ossareh
ASSISTANT PROFESSOR, ELECTRICAL ENGINEERING
Hamid comes to us from Ford Motor Company, where he worked as a Research Engineer on advanced automotive control systems. His work has been published in the IEEE and ASME transactions, among others, and he holds numerous patents in the area of automotive systems and control. He regularly presents at conferences, workshops, and seminars. He is currently investigating optimal constraint-aware control algorithms with applications in power and automotive systems. He earned his Ph.D. in electrical engineering – systems (control theory) from the University of Michigan in 2013 and his B.A.Sc. from the University of Toronto in 2008.

8 Pavan Racherla
RESEARCH ASSISTANT PROFESSOR
Pavan's research interests lie at the intersection of weather, climate, and energy systems, which currently takes the form of electricity distribution circuit modeling and near real-time solar/wind energy forecasting. He has a Ph.D. in engineering & public policy from Carnegie Mellon University, and thereafter was as a postdoctoral and associate research scientist at NASA Goddard Institute for Space Studies through Columbia University. He is a co-founder of NextClimate, a social enterprise that empowers people to take action on climate change.


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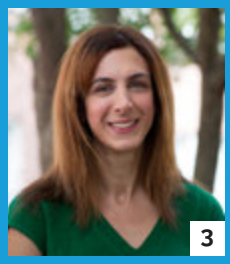
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9 Dustin Rand
SENIOR LECTURER, MECHANICAL ENGINEERING
Dustin comes to us from North Branch Engineering in Montpelier, Vt., where he was principal electrical engineer focusing on power systems integration, conversion, distribution, and interconnection with a focus on the renewable energy market. Previously, he was a senior electrical engineer at Northern Power Systems in Barre, Vt. He received his undergraduate and master's degrees from Northeastern University.

10 Lauren Petrie
COORDINATOR, CAREER READINESS PROGRAM
Lauren received her Bachelor of Arts in communication studies, and business in 2014 and Master of Science in college student personnel in 2016 from the University of Rhode Island. She has worked in many areas in the higher education field, including first year experience, orientation, health education, career services, and a women's center.

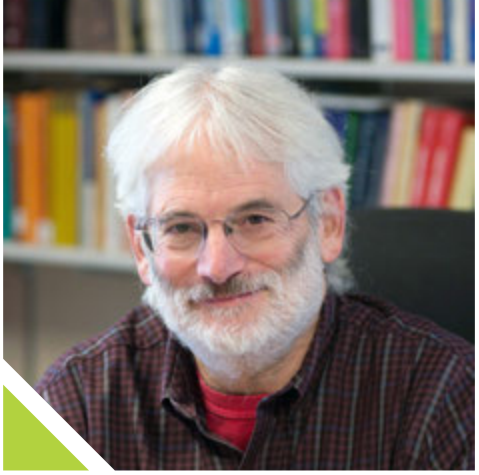
11 Amanda Wells
ACADEMIC ADVISOR, STUDENT SERVICES
Amanda earned a Bachelor of Science in environmental science from Johnson State College, where she also completed the Science Teacher Education Program. Prior to joining UVM, Amanda worked as an academic advisor for a small Vermont college and previously served as the Student Development Coordinator for TRiO Upward Bound.

PROMOTIONS

12 Marnie Owen
ASSISTANT DEAN FOR STUDENT SERVICES
Marnie has served the College of Engineering and Mathematical Sciences previously as director of student services. She holds a bachelor of arts degree in political science, and a master of education in higher education & student affairs administration, both from the University of Vermont. Her previous roles have included coordinator of transfer evaluation at the Community College of Vermont, records analyst in the UVM Office of Transfer Affairs and academic advisor for Student Services in CEMS.

13 Christian Skalka
ASSOCIATE DEAN FOR FACULTY AFFAIRS
After serving effectively as acting chair of the Department of Computer Science, Christian brings a strong commitment to faculty affairs and success to his new position as associate dean for faculty affairs. Christian has been a member of the UVM faculty since 2002. His research interests include programming languages, cybersecurity, and computational methods in environmental science. Christian received his B.A from Saint John's College, an M.S. from Carnegie Mellon University, and a Ph.D. from Johns Hopkins University.

Dinitz Named Williams Professor



Dr. Jeff Dinitz, professor in the Department of Mathematics and Statistics, has been appointed as the Williams Professor of Mathematics. The Williams Professorship was established in 1853 and honors Azarias Williams of Concord, Vermont, merchant and judge, native of Sheffield, England who in 1839 deeded extensive land holdings to the University of Vermont.

Professor Dinitz teaches a wide range of courses to undergraduates and graduate students. He is also an internationally recognized research mathematician with 94 publications in refereed journals, 25 book chapters, nine research reports, nine keynote talks at major conferences, 57 invited talks, and 17 contributed talks. Since 1997, he has served as editor-in-chief of the *Journal of Combinatorial Designs,* the most prestigious journal in combinatorial design theory, as well as serving on the editorial board of the *Journal of Discrete Mathematics.* Professor Dinitz is best known for co-editing the *Handbook of Combinatorial Designs,* the definitive reference work for combinatorial designs. He was named a University Scholar in 2008-2009 in recognition of the quality and productivity of his research.

CEMS RESEARCH AWARDS

FACULTY FROM ACROSS THE COLLEGE ARE ENGAGED IN LEADING-EDGE RESEARCH SPONSORED BY THE NATIONAL SCIENCE FOUNDATION, NASA, AND OTHER FUNDING AGENCIES.

FOR MORE AWARDS VISIT
WWW.UVM.EDU/CEMS

PRINCIPAL INVESTIGATOR	SPONSOR	PROJECT TITLE	AWARD
Mads Almassalkhi	DOE	Packetized Energy Management: Coordinating Transmission and Distribution	$1,691,746
Lisa Aultman-Hall	VT AOT	Designing an "All-in-One" Transportation Survey for Vermont	$65,502
Joshua Bongard	NSF	EAGER: Scalable Crowdsourced Reinforcement of Robot Behavior	$123,136
Jeff Buzas	VT Oxford Network	Statistical Support for the Vermont Oxford Network	$169,206
Douglas Fletcher	NASA	Experimental and Numerical Investigation of Ablation Kinetics	$225,000
Paul Hines	GMP Corporation	Using Smart Grid Data to Identify Geographic Locations for Targeted Investment	$67,872
Jeffrey Scott Marshall	NSF	IGERT: Smart Grids - Technology, Human Behavior and Policy	$604,685
Tian Xia	NASA	Design and Validation of High Date Rate Ka-Band Software Defined Radio of Small Satellite	$99,890
Jianke Yang	Air Force	Theory and Applications of Nonlinear Optics in Photonic Lattices and Metamaterials	$148,019
Rachael Oldinski	NIH	Development of a Polysaccharide-Based Patch for Use as a Therapeutic Lung Sealant	$1,505,256
Frederic Sansoz	DOE	Strenthening Nanotwinned Metals beyond the Hall-Petch Limit	$586,000
Douglas Porter	NPS	Stabilization and Repair of the Bartlett Cabin, Pecos National Historical Park	$180,000
James Sullivan	VT AOT	Bicycle and Pedestrian Counting Program Management	$74,244

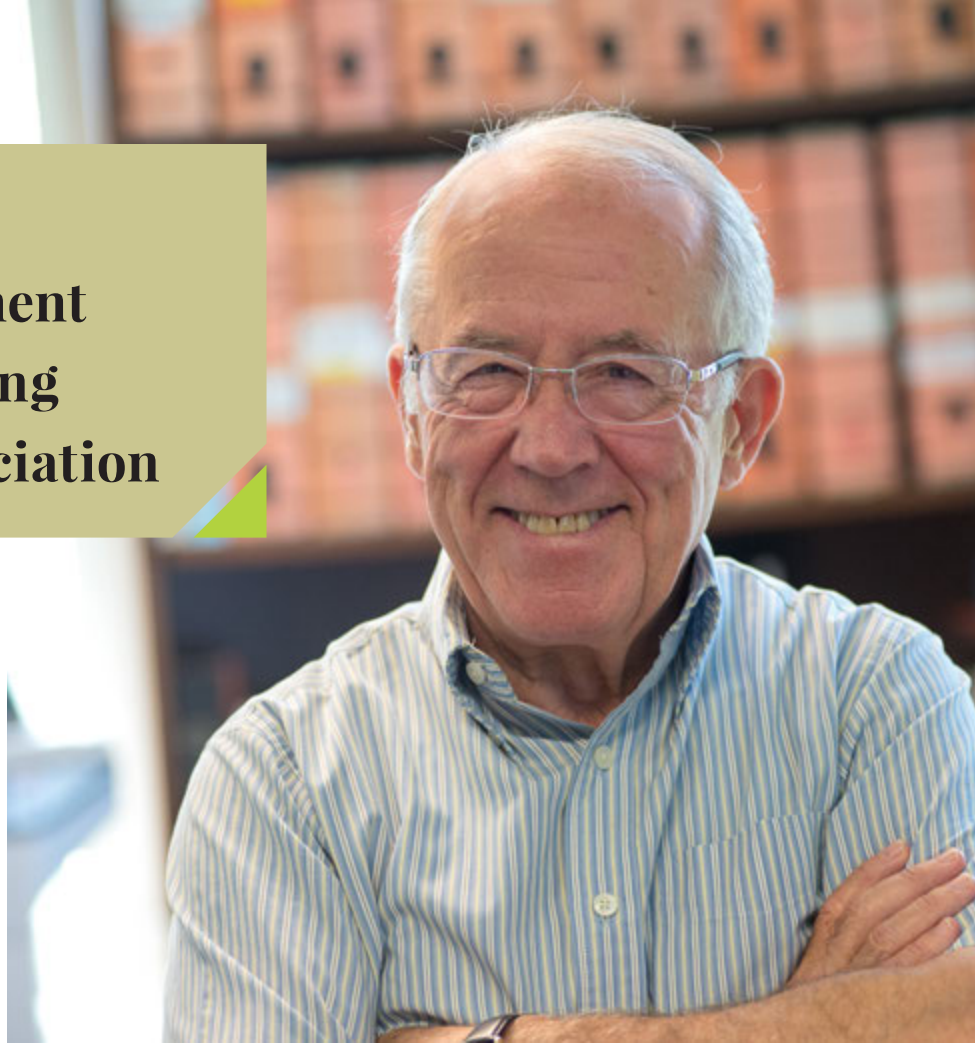
CEMS BY THE NUMBERS

21.9%

FEMALE ENROLLMENT IN CEMS HAS GROWN BY 17.1% IN THE LAST THREE YEARS TO 21.9%

Photo: Sally McCay

Pinder Receives Lifetime Achievement Award from Leading Professional Association



BY JEFF WAKEFIELD

George Pinder, a professor of civil and environmental engineering in UVM's College of Engineering and Mathematical Sciences, has won a lifetime achievement award from the Environmental and Water Resources Institute (EWRI), a division of the American Society of Civil Engineers.

Pinder, a national authority on using mathematical modeling to predict the movement of pollutants in groundwater, was honored at a ceremony in West Palm Beach, Florida, on May 23.

The EWRI award is given to individuals who have made a significant contribution to their field over the course of their careers.

"George has made major advancements in our ability to understand the movement of pollutants in groundwater, helping inform wise public policy and improving human welfare," said Jery Stedinger, chair of the EWRI awards committee and a professor in the School of Civil and Environmental Engineering at Cornell. "His consistent leadership over the years and his mentoring of junior scientists have pushed the profession forward. It's a great occasion to be able to give this award to someone like George, who is so admired by his colleagues and has made such a contribution over a long period of time."

Pinder has received numerous other awards during his career, culminating in his being named a member of the National Academy of Engineering in 2010, the most prestigious honor in the field.

Pinder famously inspired a character bearing his name in the 1998 Oscar-nominated film *A Civil Action,* starring John Travolta, which was based on a real case brought by residents of Woburn, Massachusetts, against W. R. Grace and Beatrice Foods. The plaintiffs accused the companies of allowing carcinogens on their manufacturing sites to leach into the water table, causing an epidemic of fatal leukemia cases.

During the real trial, Pinder spent 12 consecutive days on the witness stand. While the case was settled for less than the plaintiffs had hoped, the Environmental Protection Agency, building on Pinder's testimony, successfully sued both companies.

Pinder is still invited to make presentations on the case, which is considered foundational in environmental law, about a twice a year.

OTHER RECOGNITIONS INCLUDE:

The Horton Award, presented by the American Geophysical Union for an outstanding paper on hydrology (1969)

The O.E. Meinzer Award, presented by the Geological Society of America for an outstanding contribution to the field of hydrogeology (1975)

Fellow, the American Geophysical Union (1993)

The Julian Hinds Medal of the American Society of Civil Engineers for advancing engineering in the field of planning, development, and management of water resources (2002)

The American Society of Civil Engineers Distinguished Member Medal (2012)

Honorary Diplomate, American Academy of Water Resources Engineers (2016)

Photo: Sally McCay

BY JOSHUA BROWN

HEALING WITH SEAWEED

From cancer to punctured lungs, applications are promising

Rachael Oldinski would like to cure cancer, replace cartilage, and patch punctured lungs—with seaweed. Okay, it's more complicated than that. But, one afternoon this spring, behind the locked doors of her lab in Votey Hall—the Engineered Biomaterials Research Laboratory—the professor points to three of her graduate students and four undergrads. "Everyone here works with alginate," she says, "which is purified seaweed."

You might call it the goo lab. Canaan McKenzie '16 holds up a clear strip of gelatinous plastic that he made with several natural products including alginate and collagen. "The collagen is from the livestock industry," he says. "It's exactly the same stuff as goes into Jell-O."

Sarah Blatt '16 is working with Oldinski to create a jelly to see how well it will mimic the properties of the inner region of the human spine. Normally, this nucleus pulposus gel is the shock absorber within the discs between each vertebra. "But in disease, that jelly leaks out," Oldinski says. So, as a senior project, Blatt is looking for a "material replacement," she says.

"We also work, literally, with snot," Oldinski says with an unguarded smile. "We have several projects that use hyaluronic acid," the clear goo that the body creates to lubricate joints, shape eyeballs and, yes, "it's snot," Oldinski says.

Follow Rachael Oldinski on twitter: @uvmEBRL

Underlying the great-fun-with-squishy-stuff ethos of the lab, Oldinski has a deadly serious set of goals. One is to do basic work on the mechanics and chemistry of these various goos, a family of materials called hydrogels. "Can we create products that are smart—that are responsive to changing pH or temperature or biological conditions? Can we create products like skin, that stretch and reorganize themselves over and over without failing?" Oldinski asks. On the other side of the bench from her, doctoral student Spencer Fenn squirts a purple blob of alginate onto a glass slide and spins the slide inside a small centrifuge.

He then places the goo-covered-slide inside a box filled with green LED lights. Because of complex manipulations he's done to the goo's chemistry, under the light the long strands of polymers within the liquid will link with other strands. After a few minutes, he takes out the slide. "See, it's become a hydrogel film. It's no longer a liquid; it's a solid."

Fenn has been spearheading a research effort to use alginate gels to create a kind of Band-Aid for the lung. Whether from a car crash or disease or battlefield injury, once a lung is punctured it is difficult to seal and heal, since it is constantly inflating and deflating. He and Oldinski and others in both UVM's College of Engineering and Mathematical Sciences and Larner College of Medicine have developed a patch that looks promising for clinical use. Once it is freeze-dried, a surgeon will be able to cut a piece of the hydrogel, apply it to the wound and let it rehydrate from the body's own water. Then, using a scope with a green light, transform the goopy patch into an adhesive lung sealant. This innovation promises to be non-toxic and a recent study by the lab team shows that the patch can withstand lung-like pressures.

But Oldinski's top goal for developing hydrogels and other engineered biomaterials is to find better forms of drug delivery, particularly for cancer treatments.

In another room of the lab, Oldinski's team experiments with lines of human cancer cells. Eventually, this drug-soaked patch will be tested there to see how well it works. "The patch and the particles will release the drug at different rates," Fenn notes—aiding a steady flow of medicines locally in the body. "After a doctor removes a tumor, there are often residual cancer cells left," he says. "You could apply this patch on the site of the surgery, which would release high concentrations of the chemo drug there, but keep systemic concentrations down."

At the other end of the lab bench, doctoral student Tianxin Miao works quietly, using a tabletop shaker to mix water and oil in a beaker. It's part of a complex process to create nanoscale alginate particles. "They're like a meatball of water, seaweed, calcium chloride and a drug," Miao says. Except the balls are thousands of times smaller than the period on the end of this sentence. What Miao, Oldinski, and Jeffrey Spees, a professor in UVM's Larner College of Medicine, have discovered they can do with these tiny particles of seaweed may "be huge," Oldinski says. "It could be a brand-new treatment for cancer."

> "CAN WE CREATE PRODUCTS THAT ARE SMART—THAT ARE RESPONSIVE TO CHANGING PH OR TEMPERATURE OR BIOLOGICAL CONDITIONS? CAN WE CREATE PRODUCTS LIKE SKIN, THAT STRETCH AND REORGANIZE THEMSELVES OVER AND OVER WITHOUT FAILING?"
>
> — RACHAEL OLDINSKI

The nanospheres Miao created are "really ninja beads," Oldinski says. Recent reports show that a naturally occurring protein, called fibroblast growth factor 2, that sends signals on the outside of cells, behaves very differently—if it gets inside a cell. There, it can function like a hormone to inhibit growth and kill cells—including cancers. Using this knowledge, Miao and Oldinski mixed the growth factor into a highly engineered form of their alginate meatballs, called alginate-graft-PEG, and then released them into a sample of human lung cancer cells.

The scientists were pleased and amazed that the nanospheres slipped past the cells' surface receptors for the growth factor—and got inside. There, the tiny alginate balls moved to the cells' nuclei "and released their bomb: the growth factor," Oldinski says. "It kills the cancer."

At its foundation, Oldinski's aim is to imitate nature "to replace nature," she says—but then to use the replacement materials to restore regular biological function. Take the cartilage in a knee. She and her students study the mechanics and elasticity of complex mixes of natural materials that could be used to replace damaged cartilage. But a deeper solution to the problem requires a deeper imitation of nature. "For true healing, the gold standard is cell replacement," Oldinski says. And she sees a role for hydrogels in that too: she and her students are working on products that could be used to temporarily replace damaged cartilage but would also carry drugs and stem cells that themselves would attract the body's own stem cell production.

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Photo: Joshua Brown

BY JEFF FROLIK

AERO

Alternative Energy Racing Organization

AERO ALLOWS STUDENTS TO STRETCH THEIR ENGINEERING MUSCLES, APPLYING CLASSROOM LEARNING TO HANDS-ON PROJECTS

In May of 2016, UVM's Alternative Energy Racing Organization (AERO) club presented their electric car at the Institute of Electrical and Electronics Engineers (IEEE)/Society of Automotive Engineers (SAE) Hybrid International Competition. But the path to this year's competition was rockier than usual. After having some setbacks with their manufacturers just six weeks ahead of the event, the UVM team decided to go in a completely different direction and start again from scratch—scrapping the 18 months invested into the project. Though the task was daunting, the members of AERO were well equipped to take on this challenge.

AERO is a student-run group that gives students the opportunity to work on projects that advocate for research and development of alternative energy drive systems, and students apply what they've learned in the classroom. They test out their skills, learn from their mistakes, network with like-minded individuals, and explore all that is theirs to discover.

"Whenever I've been out for an interview or talking to potential employers," says Emily Bolt '17, "I have AERO as a pretty thick line on my resume."

Even the AERO logo (which harkens back to an iconic ACDC font complete with lightning bolt) tells you something about the club and the kind of students who are involved: these are young men and women who work incredibly hard to push the boundaries of engineering at the University level. This year, they didn't just build an electric car, they built an electric car in six weeks.

The IEEE/SAE Hybrid International Competition takes place annually at the New Hampshire Motor Speedway as part of the SAE Collegiate Design Series. The challenge, as described by the Formula Hybrid Competition, is to "collaboratively design and build a formula-style electric or plug-in hybrid racecar and compete in a series of events. This educational competition emphasizes drivetrain innovation and fuel efficiency in a high-performance application."

The showcase is interdisciplinary, requiring mechanical, electrical, and

Check out AERO's latest video at http://www.uvmaero.org/

RACING TOWARD THE FUTURE:

(Left) Andrew Giroux prepares Greenspeed 4 for competition
(Right) Driver Braedon Lohe supported by Greenspeed 4 teammates: Nate Rex, Emmie Bolt, Carlo Giorelli, Will Baker, and Jack Thomae
(From page 1) Driver Jack Thomae races Cleanspeed 2 in 2016

computer engineering skills, and is international, drawing in schools from around the world, including Turkey and India. And it is competitive, attracting the best of the best from Dartmouth, Renssalaer Polytechnic, Yale, Princeton, and more.

This year, UVM's AERO submitted the CleanSpeed 2. They placed 2nd in the Electric competition, placed 3rd overall behind the University of Victoria and SUNY-Binghamton, and was awarded the IEEE Excellence in Electric Vehicle Engineering. But perhaps the greatest success of the day was that the CleanSpeed2 was the first car in the competition's history to complete the 44-lap endurance event.

"Once again, UVM has shown it can hold its own against the biggest engineering schools along with some private ivies," says AERO's advisor Dr. Jeff Frolik, professor of electrical engineering.

Neil Holman '18 adds, "Those six weeks were a fast-paced learning experience for many; I'm very proud to have been a part of it."

AERO

Photos: Courtesy of Formula Hybrid Competition

Close to You

RARE PROXIMITY OF ENGINEERING AND MEDICINE AT UVM GIVES RISE TO NEW MAJOR, NEW HORIZONS FOR UNIVERSITY

"WE ARE EXCITED TO OPEN THE CUTTING EDGE FIELD OF BIOMEDICAL ENGINEERING TO OUR STUDENTS."
– DEAN LUIS GARCIA

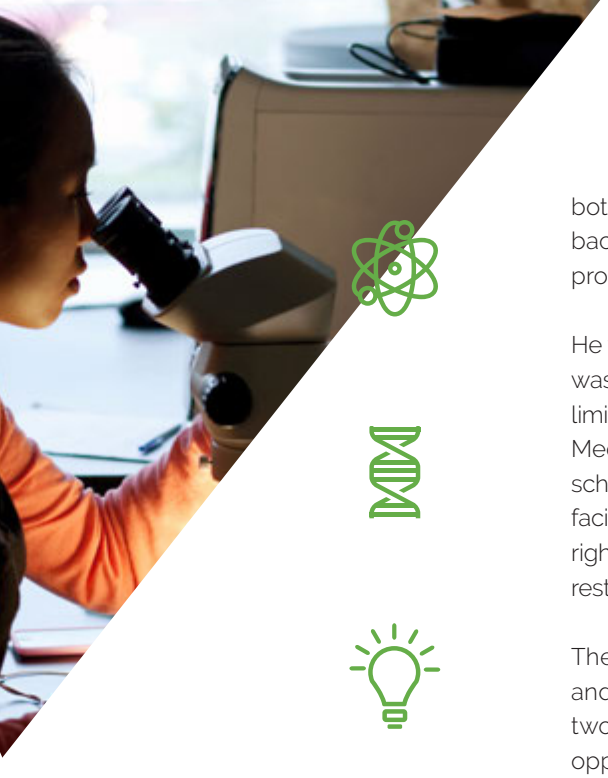
BY JEFF WAKEFIELD

Stretching between Votey Hall, home to the University of Vermont's College of Engineering and Mathematical Sciences, and the Larner College of Medicine's Medical Education Center is a jumble of chain link fences, construction equipment and hulking, partially built structures – ground zero of an ambitious construction program, about half done, being undertaken by the university and its teaching hospital, the UVM Medical Center.

But even the roundabout walkway between the buildings that gives construction hazards a wide berth can be traversed in a little under four-and-a-half minutes.

Both the nearness of the buildings and the impediments that prevent an even quicker passage between them are significant—foundational elements of an ongoing commitment the university is making to what may be the

Photos: David Seaver, Mario Morgado



great intellectual enterprise of our time: using the quantitative methods of mathematics, computer science and engineering to understand biological systems and solve deeply complex biomedical problems.

In a sign of this commitment, the university this fall unveiled a new undergraduate major in biomedical engineering three years in the making. It joins a Ph.D. in bioengineering launched in 2010 and previews a master's in the discipline the university will put in place within two years.

UVM's emergent trio of biomedical engineering degree programs has top tier potential, says the university's provost, David Rosowsky.

In his previous job as dean of the School of Engineering at Rensselaer Polytechnic Institute, Rosowsky presided over one of the nation's leading biomedical engineering departments.

As he was eyeing UVM from afar and after he arrived in 2013, Rosowsky was impressed by the talent of the faculty in both the engineering college and the university's highly ranked medical school—and by how many faculty in both academic units had educational backgrounds and active research programs in biomedical engineering.

He was also struck by something that was missing at RPI and, to an extent, limited it: the fact that "our College of Medicine"—RPI has neither a medical school nor a clinical translational research facility like UVM Medical Center—"sits right on our campus, co-located with the rest of the university," he says.

The combination of faculty talent and interest and the nearness of the two colleges presented "an obvious opportunity to invest in an area that was very compelling to students, very compelling to federal agencies supporting research and very attractive to employers," he says.

Two years after Rosowsky arrived, as part of a strategic plan developed by the university's president, Tom Sullivan, UVM began construction on a new $104 million STEM facility—one of the impediments that necessitates the circuitous path from Votey to the med school. Across the way, the UVM Medical Center recently broke ground on another—a new patient care facility that will bring engineering and medicine even closer.

The investment in the new STEM facility doesn't overlook biomedical engineering. A large, state-of-the-art biomedical engineering teaching and research lab will be housed in Votey Hall, much of which will be gutted and rebuilt as part of the STEM project.

CONSEQUENTIAL COLLISIONS

The proximity of engineering and medicine at UVM is rare in American higher education. At the vast majority of the 50 universities that have both accredited biomedical engineering programs and medical colleges, the two units are located across town from one another (think Tufts in Medford and Tufts Medical School in Boston's Chinatown) or even across the state (Cornell in Ithaca and Weill Cornell Medicine in Manhattan, for example).

The location of the schools being a "stone's throw from one another creates unique synergy," say Luis Garcia, dean of the College of Engineering and Mathematical Sciences.

Rachael Oldinski, a rising faculty star in biomedical engineering in the college, is a case in point. Oldinski and a group of faculty at the College of Medicine's Vermont Lung Center are hard at work on an ingenious invention she calls a "lung Band-Aid" —a patch of organic matter derived from seaweed that can be used to repair the hole of a collapsed lung and "potentially save a life," she says.

But if a post-doctoral student at the med school, Darcy Wagner, hadn't wandered over to Votey to catch a seminar Oldinski was teaching and talk with her afterwards about a challenge she and her advisor, Dr. Dan Weiss, a pulmonary specialist at the Lung Center, were facing, the invention may never have been conceived.

"She came to my seminar and said, 'This is what we're having trouble doing,' and I said, 'Well, I have something that will probably solve your problem,'" Oldinski says. "And then she came back to me and said, 'You know I think your solution would actually be good for something else.' One thing led to another and to another, and the lung Band-Aid was born. It happened only because of the people and the location," Oldinski says.

Biomedical Engineering major, Luis M. Garcia '19

EXPLOSIVE GROWTH

Biomedical engineering as a field is experiencing explosive growth, says Jason Bates, a biomedical engineer and professor of pulmonary medicine in the Larner College of Medicine, who helped launch the bioengineering Ph.D. as interim director of the School of Engineering, a role he played from 2010 to 2014. Bates and Jeff Frolik, professor of electrical engineering in the College of Engineering and Mathematical Sciences, are co-directors of the new undergraduate program.

The growth is being driven along two tracks, says Bates. "There's the technology involved in healthcare delivery," he says, which grows exponentially every year and includes everything from smart prosthetics to diagnostic tools like CAT scanners to the safe and standardized manufacture of new pharmaceuticals.

"Then there's the technology involved in making fundamental investigations into biology as a biomedical system," he says. "Medicine and biology have developed to the point where you just can't get away from the need for serious quantitative methodology in much of it. Engineers are people with hammers looking for nails. And in medicine, we've got a lot of nails."

All that growth means better healthcare outcomes for patients—and a burgeoning job market for biomedical engineers. The Bureau of Labor Statistics projects a 23 percent increase in the number of biomedical engineering jobs between 2014 and 2024, a "much faster than average" rate of growth according to the bureau. In 2015 the median income of biomedical engineers was of $86,220.

That rosy projection rings true for alum Dan Nardi (B.S. in mathmatics, 2002/M.S. in computer science, 2004), vice president for operations at Livongo, a Chicago-based chronic disease management company, and a member of the CEMS advisory board who was an early advocate of the new undergraduate degree.

"Being out in Silicon Valley a lot and just picking up as much as I can on all the blogs, I certainly think there is more and more demand," he says.

Nardi also mentors healthcare startups in the Chicago area "and a lot of entrepreneurs want to have a background like this because there's so many applications."

UVM biomedical engineering graduates would be welcomed by "a whole new wave of startups," he says.

MORE THAN BRICKS AND MORTAR

The university's investment in biomedical engineering extends beyond the bricks and mortar of the new biomedical lab and the STEM facility of which it is part.

According to Garcia, the College of Engineering and Mathematical Sciences brought on a new instructor in the discipline in August and plans a tenure track "cluster hire"—two biomechanical engineering faculty recruited simultaneously, one with a concentration in electrical engineering and one in mechanical—this academic year.

The university is also investing in a program that will award "substantial seed grants," according to Rosowsky, to teams of faculty from engineering and medicine who jointly submit research proposals.

The grant program is a way of further ramping up research partnerships between colleagues in UVM's engineering and medical colleges, a group that has often worked together in the past whose tradition of collaboration led to the bioengineering Ph.D.

Photo: David Seaver

UVM BIOMEDICAL ENGINEERING GRADUATES WOULD BE WELCOMED BY "A WHOLE NEW WAVE OF STARTUPS," SAYS CEMS ALUM DAN NARDI

The new undergraduate program should promote even more connection, Garcia says. Faculty from the two schools will be entwined, with engineering faculty primarily teaching the first three years, medical school faculty offering special topics courses senior year, and much interplay all four years.

"You're going to be working together teaching, and working together in developing some of the programs," he says. "We see a clear spillover into doing more research together."

WANTED: GENDER BALANCE

The attractiveness of the new undergraduate program and the popularity of the major across higher ed should help the College of Engineering and Mathematical Sciences continue its strong enrollment growth, a strategic goal of the university and the state of Vermont. The unit has more than doubled its enrollment in the last decade.

It will also help with another challenge facing UVM and universities everywhere: tipping the scale toward gender balance in the male-dominated field of engineering.

"Biomedical engineering nationwide is about 40 percent female," says Garcia. "We're confident our program will get to that level," which should boost overall engineering enrollment well above its current ratio of 21 percent female to male, a figure higher than the national average for engineering schools but not where the college wants to be.

A larger female enrollment would, in turn, "attract other underrepresented categories," says Frolik. "All the students would be taking the same first and second year classes, so we'll have a much more diverse population." Why more women are attracted to biomedical engineering is a complicated question. Bates and others guess that it's "because of the more immediate social implications of being able to directly help people."

Oldinski says role modeling plays a large part. "Where did a lot of women start to become comfortable within engineering?" she asks. "I think biomedical engineering was one place. And as soon as you have one biomedical engineering professor, there's your pipeline of female students."

The example of Kiki Cunningham, a sophomore mechanical engineering major from Old Chatham, N.Y., who's switching to biomedical engineering now that the major is available, suggests that those reasons may be intertwined.

While in high school at Emma Willard in Troy, Cunningham got a tour of the General Electric facility in nearby Schenectady and was inspired by a young woman there, who told her about a project she was working on to make synthetic skin for burn victims. Cunningham was drawn to the person but also to the field's ability to make a human impact. "Originally I wanted to go into internal medicine to help people," she says. "After that presentation and after doing more research, I saw more ways I could help people being a bioengineer than an M.D."

GOOD TO GREAT

UVM's expansion of its biomedical engineering program is a clear advance for undergraduate education at the university; the only surprise is that it didn't come earlier. "UVM has everything you'd want for the degree," Oldinski says. "The students have the ability to get into the classroom, to go over to the hospital, to volunteer, to work with faculty in the College of Medicine and the College of Engineering and Mathematical Sciences, the Material Science program in the College of Arts and Sciences, the College of Nursing and Health Science."

And the educational experience is delivered—in both engineering and medicine (as well as in the university as a whole)—via a teacher-scholar model emphasizing small classes taught by faculty with expertise in research and teaching.

As the undergraduate enrollment grows and feeds the soon-to-come-online master's program, as both programs serve as a pipeline to the doctoral program, and as all student levels swell a research program already growing due to increased collaboration between next-door-neighbor faculty in engineering and medicine, it's hard not to get carried away by biomedical engineering's potential at UVM.

"This is a great opportunity for the university," says Rosowsky. "It's also a great fit for the university."

Photo: Rick Levinson

BY SUJATA GUPTA

INNOVATION IN ACTION: SENIOR PROJECTS

Edmunds Elementary School Bioretention Garden & Stormwater Mitigation Rendering

Design Night Showcases Engineering for the Community

Senior Nate Rex's project may have scored points for speed and energy efficiency, but it was just one of 43 examples of student innovation on display at the annual Design Night event on April 29, which showcased "capstone" projects completed by seniors majoring in civil, environmental, electrical, and mechanical engineering.

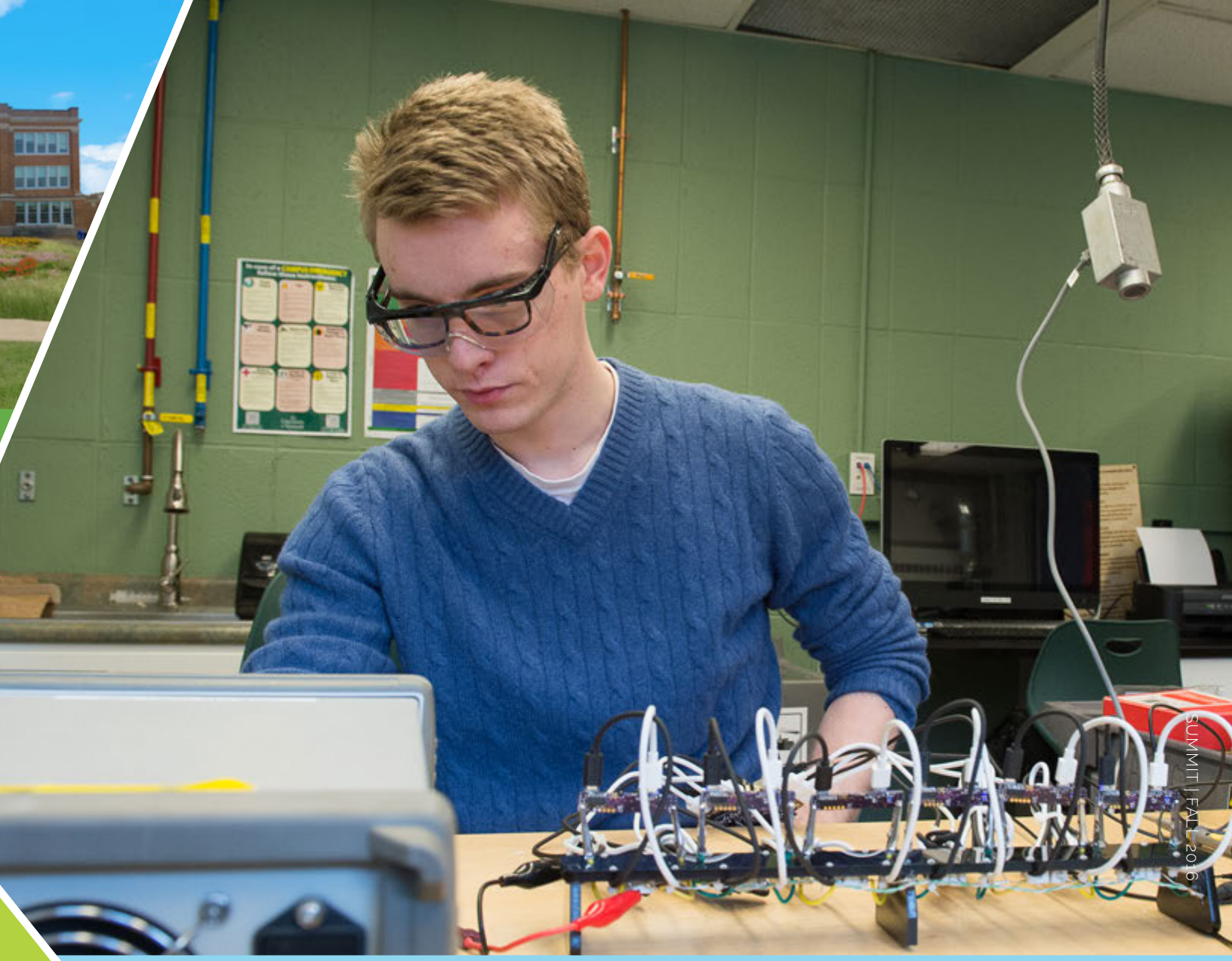
The purpose of the capstone, which depending on a student's major takes one to two semesters to complete, is to let College of Engineering and Mathematical Sciences students take the skills they've acquired over the years and apply them in a real-life setting.

Some, like Erica Quallen's Stormwater Mitigation team, are tasked with providing the vision for a project. Others have developed actual prototypes. A look around the room on Design Night reveals a machine that simulates splitting logs and a palm-sized sensor designed to measure wind speed and direction atop a wind turbine. And sitting just outside is an all-electric car built almost entirely from scratch—Rex's handiwork.

Nate Rex began preparing for real-life challenges ever since he arrived at the university. A member of the school's Alternative Energy Racing Organization, or AERO, since his freshman year, Rex has spent years helping his team design electric and hybrid vehicles. Many of those vehicles have gone on to win awards at the annual Formula Hybrid Racing Competition, an inter-collegiate event held at the New Hampshire Motor Speedway in Loudon.

Since the club's inception in 2008, several seniors have tweaked various parts of the car for their capstones. This school year, for their capstone—the Control System and Battery Management System for AERO Vehicle—Rex and two other seniors decided to replace the prefab battery management system with one they had designed. Such systems are necessary for battery packs to remain within their so-called safe operating area, essentially the voltage range within which a cell can operate before destructing. The 30 cells inside his pack, Rex explains, all discharge at different rates, which makes for a very complicated math problem.

But the AERO team's greatest challenge was logistical. How could they design 30 pinky-sized circuit boards, one for each battery within the system, that all performed in exactly the same way? Of the first batch of circuit boards the team created, Rex says, only half worked and they all had different mistakes.



STUDENT INNOVATION

Nate Rex began working with the student club AERO his freshman year. For his senior design project, he and two other seniors replaced the car's prefab battery management system with their own design.

Then, on March 14, just six weeks before the 2016 Formula Hybrid Racing Competition, the team decided to scrap the car they'd been working on for over a year—it's a long story, Rex says—and start from scratch. Because the old car had been a hybrid and this new one would be all-electric, it required a new battery management system. Luckily, Rex and his team soon realized that they could utilize the same general principles they'd learned in their previous work.

The team's 11th-hour decision paid off. At this year's competition, they placed second in the all-electric vehicle class, broke a competition record for the longest distance traveled, and won an excellence in electric vehicle design from IEEE.

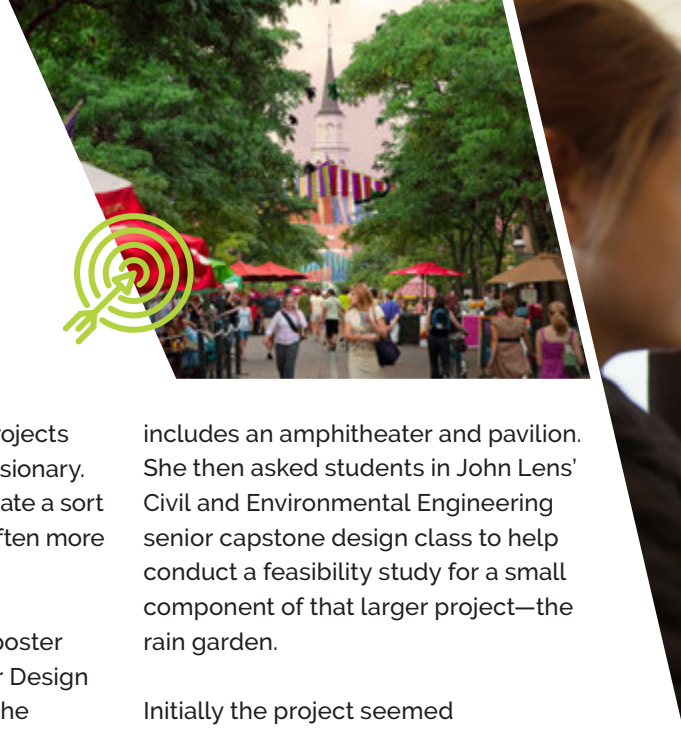
This August, Rex began work as an electrical engineer at IBM in Essex. The hiring managers, he says, seemed impressed with his "ability to identify failures and efficiently troubleshoot a problem."

Nate Rex is not the only one to turn his capstone experience into a professional opportunity. Team members working on the Communication for Mechanically Ventilated Patients project, for instance, are now trying to patent their device.

That device is designed to help patients on mechanical ventilators (machines that help patients breathe) communicate with caregivers and family members. Right now, explains

Photo: Sally McCay

BY THEIR NATURE, THE SENIOR CAPSTONES SERVE AS A BRIDGE BETWEEN STUDENTS AND THE GREATER BURLINGTON COMMUNITY.



team member Peter Gibson, when medical staff or family members want to speak to a patient on a ventilator, they show them a sheet of paper illustrated with various pictures and phrases and ask them to select one. The patient, for instance, can choose the picture of a thermometer that reads hot or cold to ask for someone to change the temperature in the room or another with a dripping cloth for a cool compress. The method is laborious and the range of expressions limited.

So working with client Dr. Prema Menon, a critical care physician at UVM Medical Center, Gibson and his team came up with a better way for patients to communicate. Instead of a sheet of paper, their approach would allow patients to communicate using a tablet, like an iPad, and a controller. The algorithm the students created is able to auto-complete a patient's sentence. "At least in our trials it was able to give a more detailed response than the standard communication device," Gibson says.

"The senior design course essentially walks students through this whole process of doing a design from the problem statement, looking at some alternative approaches, and then trying to narrow down to which approach to use," says client Barry King, the lead electrical engineer at Renewable NRG Systems in nearby Hinesburg. "Solving a complex problem in a time-limited senior project is very ambitious."

The capstone also benefits the broader community. With typical clients drawn from area government, technology, and nonprofit agencies, the projects are often far-reaching, even visionary. Viewed in aggregate, they create a sort of template for a better and often more sustainable world.

Erica Quallen described the poster hanging behind her on Senior Design Night. "This is a rendering of the garden," she says. "There will be a little path for people to walk through."

The garden is just part of the project—known as the Edmunds Elementary School Stormwater Mitigation and Rain Garden—put together by Quallen, a civil and environmental engineering major, and her team. The team's overarching goal was to demonstrate how to prevent stormwater from running off the paved areas around Edmunds Elementary School in downtown Burlington and into the area's waterways. If implemented, the project would improve the region's stream, river, and lake water quality.

The client for the Stormwater Mitigation team was Michelle "Shelley" Mathias, the principal of Edmunds Elementary. Mathias says she has long advocated for an upgrade to the elementary school's exterior, which she describes as blighted. Because the school occupies such a central location downtown, Mathias has come to believe that it serves as a symbol for how children are treated in this community.

"Everybody who comes to Burlington to go to Lake Champlain passes by this school," she says. So Mathias came up with an ambitious half-million-dollar vision for how to upgrade the school's exterior, one that even includes an amphitheater and pavilion. She then asked students in John Lens' Civil and Environmental Engineering senior capstone design class to help conduct a feasibility study for a small component of that larger project—the rain garden.

Initially the project seemed straightforward, Quallen and her teammate Steven Bellavance said. They had assumed that the ground was made up of a sandy loam that would have allowed the water to flow into the ground, giving their system a chance to reduce the amount of stormwater leaving the site. But when they—with the help of the school's fourth-graders—dug into the ground with a coring device, they came up with silt and clay. Unlike sand, those materials hold in water like a bowl, Bellavance says. Once that bowl fills up, which could happen quickly during a storm, the stormwater would flow off site just like before.

"That was a changing point in the project because then we couldn't just infiltrate the water," Bellavance says. "We were a little shocked and a little disappointed." Learning how to overcome such challenges are integral to the capstone, which aims to take learning out of the classroom and into the tumultuous real world.

By their nature, the senior capstones serve as a bridge between students and the greater Burlington community. With this region's commitment to sustainability, many of the projects—even those outside civil and environmental engineering—involve some facet of the green economy.

(Left): Peter Gibson and Julian Joffe demonstrate their project to help patients on mechanical ventillators communicate. (Right): Andrea Elhajj, Erica Quallen, Austin Grant and Steven Bellavance display their Bioretention Garden and Stormwater Mitigation project for the Edmunds Elementary School

A case in point is the group working with Renewable NRG Systems, a local company that makes sensors and other electrical equipment for commercial wind energy companies. Their project is known as the Next Generation Wind Sensor for Turbine Control Sensing.

Team member Kyle Buswell, a mechanical engineering major, shows off a palm-sized device meant to sit atop a wind turbine. The rather unassuming gadget can measure wind speed, a proxy for energy input, Buswell says. It also "tells" the wind turbine which direction the wind is coming from so that it can rotate to face into the wind.

The sensor is certainly not the first of its kind but most competitors on the market use moving parts that can fail before the wind turbine runs through it's quarter-century lifespan. Those failures can become quite costly. So Barry King asked the UVM students to design a sensor using pitot tubes, a pressure measurement system often used to measure the speed of airplanes.

The team put together a prototype with just two tubes—the real version would have 8 arranged in a circle—and tested it inside a wind tunnel at the company's offices in Hinesburg. Their hypothesis was that the wind would get "jammed" into the tubes at different pressures—highest for tubes facing the wind and lower for those at an angle to the wind—which would allow the students to then calculate wind speed and direction.

The experiment worked. "It is certainly one of the techniques we're looking at commercializing," Barry says.

In another mechanical engineering project—the Simulator for Durability Testing of Log Splitters—students working with DR Power Company, a Vergennes-based company that makes outdoor tools, made a log-splitting simulator. Currently, says team member Patrick Foley, when DR Power comes up with a new design for a wood splitter, they test it on actual wood, which wastes countless trees. So Foley's team was tasked with creating a device that could act as a sort of virtual log.

The team developed a hydraulic system and added in parameters that they could modulate, chiefly the type of wood being split. For instance, Foley says, "maple splits differently than pine." They also worked to make the device as durable as possible, given that its primary purpose was to be rammed repeatedly at high speed.

To overcome the obstacles posed by all that subsurface clay and silt at Edmunds Elementary School, the Stormwater Mitigation team proposed removing as much as possible and replacing it with sand. It was an imperfect solution, but the land would still hold more water than now. "The water would flow offsite slower and cleaner," Quallen says.

Quallen's team estimates that the project would cost just shy of $20,000. Mathias says that the school has already secured a $5,000 grant so they're a quarter of the way there. "We believe that this is very doable. It's just that we have to go out and do the fundraising to do this," she says.

But even if it takes years for the project to reach fruition, the team believes the solution they came up with for handling those poor soils below Edmunds Elementary could benefit the community by serving as a blueprint for similar projects elsewhere in the city in years to come.

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Photos: Sally McCay, Andy Duback

ALUMNI SPOTLIGHTS

BY JACQUELINE LAWLER

NICOLE MASON

CEMS GRAD USES HER SKILLS TO HELP THOSE IN NEED

Nicole Mason (B.S. '07, M.S. '10) has been working tirelessly to help others around the world, utilizing the UVM alumni network to make it happen.

Mason reports in a phone interview from her home in California, "I took a Women and Minorities in Engineering summer course. I learned that the things people need most are electricity, buildings, and roads." She explains that, in her research, she found that women, herself included, view the ability to make a difference as highly motivating in their career choices.

Mason later had the opportunity to work with a professor on a gravity water system in Honduras. From that point on, she did not look back on her global service mission. She has been to Honduras more than ten times; she serves on the board of Clara Vista, a nonprofit founded by fellow UVM grads; she founded the nonprofit Common Action for Sustainable Development (CASD) in Nepal and the USA. After the devastating 2015 earthquake in Nepal, when Mason "didn't think [she'd] make it out alive," CASD built 200 temporary shelters.

The cross-disciplinary skills she learned at UVM put her on an equal playing field with those who are much older than she, Mason says, "I'm still ahead in thinking about alternative technologies, which UVM really stressed when I was there. UVM was also really supportive of the idea that there are skills outside of engineering that make people effective engineers."

While her humanitarian work has largely been voluntary, it is also a part of what makes her such a desirable employee. According to Mason, "Everywhere I work they appreciate what I'm doing. They have been flexible about giving me time off, so I am making a living and doing what I love."

GREG SANTORO

BUSINESS STRATEGIST HELPS GUIDE STEM INITIATIVE

Greg Santoro, class of '84 is the Senior Vice President and Chief Strategy and Marketing Officer of National Rural Telecommunications Cooperative (NRTC) and serves as the chair for the CEMS Board of Advisors. His work has helped shape the renewed emphasis on STEM at UVM.

After graduating with a B.S. in computer science, Santoro found quick success working on communication software. But he realized that it was not the work that he hoped to do for his whole life: he returned to school, receiving an M.B.A. and a master's in engineering management. During these years, he honed his skills as a strategist and a visionary, his business having the foresight to pioneer a GPS chip in cell phones. He recalls in a phone interview from his office in Washington, DC, "Back in the early 2000s, a lot of companies were not excited about putting a $20 chip in a phone. People didn't even know what it was for."

Since then, his work has taken him all over the world. His position at NRTC has even brought him back to Vermont. He is currently working on what he describes as "a pretty important solar development for people working with maple syrup. Their facilities draw a ton of power in the 4-6 weeks that they are producing, so we are helping develop a system that manages their electric load."

These days, he finds himself in Vermont frequently and, with college-age kids, thinking up ways to give back to his alma mater. He explains, "Getting the opportunity to help UVM means helping a critical resource for the whole region … Students should not be afraid to reach out to alumni. I don't know a single one who wouldn't return the phone call and offer whatever kind of advice they could … It's a really great community, and I'm glad to give back to UVM."

Photos: Courtesy Nicole Mason, Sally McCay

CYNTHIA BARNHART

CEMS 2016 COMMENCEMENT SPEAKER GIVES FIRST-HAND ADVICE TO GRADUATING SENIORS

The CEMS class of 2016 was treated to a commencement speaker who was in their shoes 35 years prior. Dr. Cynthia Barnhart, chancellor, Massachusetts Institute of Technology (MIT), has earned a long list of accolades and accomplishments since she first ventured out from the halls of UVM.

Dr. Barnhart is the first woman to fill the role of Chancellor at MIT. She has turned her attention to issues of sexual assault, the pressures of academic life in the digital age, and the quality of life and learning for MIT students, both in residence halls and in classrooms.

Prior to her appointment, she worked at MIT as a professor of civil engineering and founder and director of the MIT Transportation Initiative—a program that involves MIT faculty from across the Institute to address the need for efficient, equitable, environmentally-friendly transportation technology and systems.

Dr. Barnhart's time at UVM gave her the skillset she needed to be prepared for her career, including her first job working as a planning and scheduling engineer on the Metro Rail System in Washington, DC. She sited her ability to work with structures, soil mechanics, statics, and dynamics for her success, but ultimately found that those skills would not propel her toward her ideal career.

She jokes in her commencement address, "Sorry professors, really, it's not your fault."

Her advice to graduating seniors was therefore to understand that this stage in their lives offers them an endless number of "unknown possibilities." She referenced notable UVM grads including John Dewey and Jody Williams, as beacons of hope for the many who do not know what they want to do when they graduate from college.

Though she works in Boston, she has never been far from her UVM family. A Vermonter herself, she has a sister, brother, husband, brother-in-law, sister-in-law, and three cousins that have all graduated from UVM. She herself is the daughter of parents who did not get to go to college, with a grandmother who did not get to go to high school.

EDUCATION, AND IN PARTICULAR THE UNIVERSITY OF VERMONT, WAS AN OPPORTUNITY THAT MY PARENTS COMMITTED THEIR LIVES TO PROVIDING ME.

That commitment paved the way for a daughter who would be appointed to the UVM Board of Trustees.

In her commencement address, Dr. Barnhart emphasized that graduating seniors held in their hands "one of the hottest tickets out there today—a degree in engineering or mathematical sciences." She encouraged them, saying "You can go in any direction, even directions you cannot imagine right now."

She herself did not imagine that she would be a high-ranking administrator to one of the most prestigious and highly-regarded research universities in the world. In order to get there, she revealed in a surprise twist, "I have pretty much ignored all advice ever given to me. Don't accept the framing of life's challenges or their solutions as what they have been in the past—you have the power and capabilities to define them to match your personal goals and aspirations, and those of your generation."

Dr. Barnhart graciously and candidly passed the torch of wisdom to her now-fellow alumni. It is up to them whether they will follow in her footsteps, or blaze a wildly new and innovative path.

Photo: GradImages

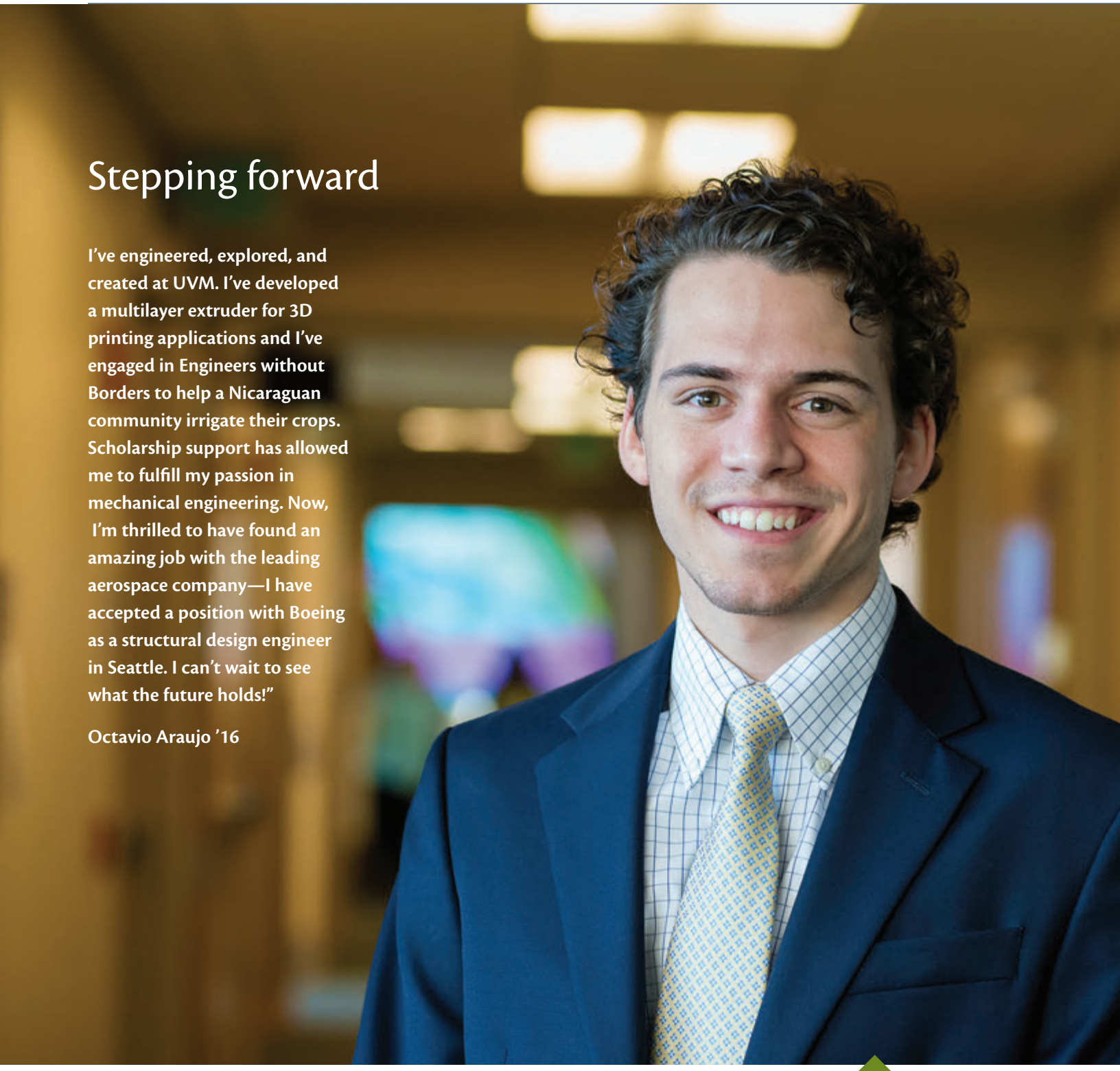
1893

2015

Engineers Across Centuries

Pictured in 1893 with the tools of their trade, these surveying students were part of the civil engineering introduced as UVM became the state's land grant institution. In the late nineteenth century, graduates of such engineering programs played an integral role in the nation's development, working on projects that ranged from improving roads and water systems to building better railroads.

Engineering professor Eric Hernandez shared the old photo at the top with his structural analysis class and challenged them to re-create it. It happened that photographer Nick Bucci was among the students and he took the bait, rounding up friends and classmates for the shot above.



Stepping forward

I've engineered, explored, and created at UVM. I've developed a multilayer extruder for 3D printing applications and I've engaged in Engineers without Borders to help a Nicaraguan community irrigate their crops. Scholarship support has allowed me to fulfill my passion in mechanical engineering. Now, I'm thrilled to have found an amazing job with the leading aerospace company—I have accepted a position with Boeing as a structural design engineer in Seattle. I can't wait to see what the future holds!"

Octavio Araujo '16

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UPCOMING CEMS EVENTS

Aiken K-12 Maker Faire and Engineering Challenge

Saturday, November 19, 2016

CEMS and the creators of the Champlain Mini Maker Faire hosted more than 1,200 attendees at Vermont's first statewide Aiken K-12 Maker Faire and TASC Challenge in 2015. This year we expect to have even more Vermont schools exhibiting their students' design and engineering projects. The event is free and open to the public thanks to funding from the George D. Aiken Fund.

Computer Science Fair

Friday, December 9, 2016

Computer Science students display web, app, and other computer related projects for the chance to win a cash prize. In 2015, 241 UVM students participated, presenting 166 unique projects. This year will be the fourth annual Computer Science Fair made possible by the Department of Computer Science and a number of sponsors.

The Robohawks of Champlain Valley Union High School in Hinesburg, Vermont competed in the 2016 FIRST Tech Challenge Competition at UVM.

Vermont FIRST Tech Challenge Championship

Saturday, February 11, 2017

Since 2013, CEMS has hosted the Vermont FIRST Tech Challenge Championship. In 2016, 13 teams from Vermont and 19 teams from five other Northeastern states competed. CEMS also hosts an annual fall scrimmage that provides an opportunity for Vermont teams to give their robots a trial run.

MathCounts Northwest Chapter Competition

February 2017

In 2016, 120 students from 13 schools participated in the Northwest Chapter Competition hosted at UVM. This event is made possible by the Department of Mathematics and Statistics and numerous other sponsors.

FOR MORE INFORMATION ABOUT CEMS EVENTS SEE **WWW.UVM.EDU/CEMS**