

The background is a dark green field filled with a complex network of thin, bright green lines. These lines connect numerous small, glowing yellow circular nodes, creating a web-like or molecular structure that fills the entire frame.

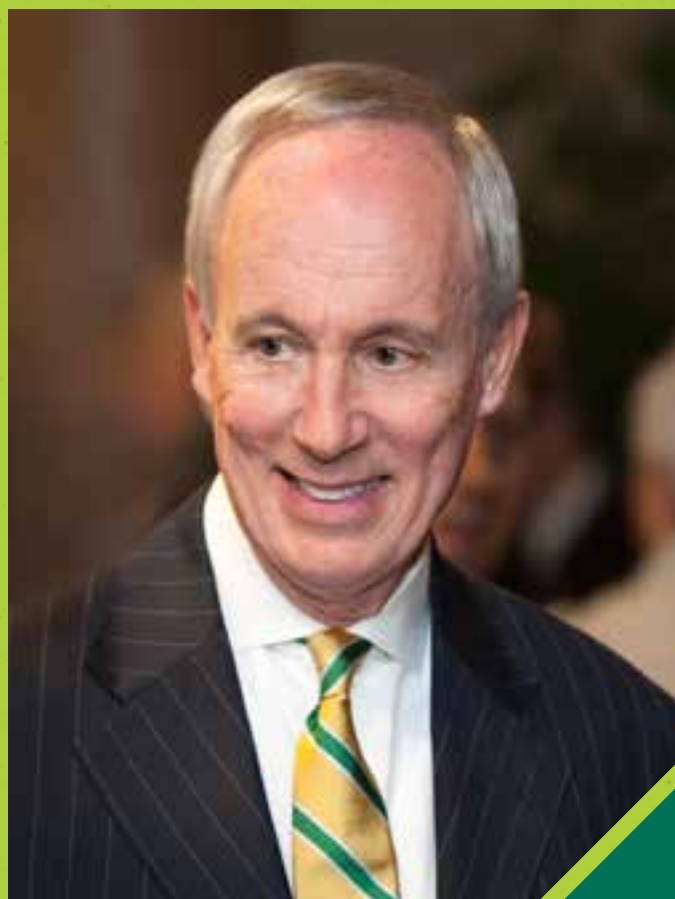
UVM

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INQUIRY

2017

RESEARCH, SCHOLARSHIP AND THE ARTS
AT THE UNIVERSITY OF VERMONT



Advancing Knowledge and Innovation

The University of Vermont is a place grounded in the commitment to the importance of discovery and knowledge, as exemplified by our focus on the teacher-scholar model. Every day, our 1,600 faculty members are deeply involved in imparting knowledge and guiding thousands of students in their intellectual journeys. At the same time, our faculty are engaged in research, scholarship, and creative arts, bringing forth new knowledge, discoveries, and insights for the benefit of all humankind.

UVM Inquiry is a showcase for the breadth and depth of the creative efforts of the University's faculty. No report could adequately convey all the work of hundreds of faculty members — as a University we truly “contain multitudes,” to use the words of the great poet Walt Whitman. Within these pages you will find a sampling of the extensive work of our teacher-scholars over the past academic year.

The teacher-scholar model has a long history at UVM. Over the years at this Public Ivy, a great many students have learned from faculty who are engaging teachers and distinguished scholars, researchers and creative artists as well. This was recognized this past year with our dedication of a permanent display on campus that showcases the University's most accomplished teacher-scholars, acknowledging both their contribution to the discovery and the creation of new knowledge and the deep connections they have made with their students. The contributions and accomplishments of our faculty have a direct and significant effect on our students' success.

At the same time, other new initiatives have been undertaken to recognize the importance of research and scholarship. Last fall, our institution's Office of Undergraduate Research named its first recipients of a new Mentoring Award, who are nominated by any of the hundreds of student mentees who participate in UVM's annual Student Research Conference. Research and scholarship are truly the products of an unbroken chain of inquiry from one generation to the next. These awards recognize the importance of the spirit of mentorship that guides the teacher-scholar.

I have often used the term “talent magnet” in describing the role of our scholars. We see UVM as an attractor for outstanding students and staff, bringing innovation and entrepreneurship and the ideas that help our communities grow and prosper. By far the strongest force behind that magnetic attraction is the faculty talent that brings us the best students and all of the other benefits that outstanding teachers, scholars, and researchers contribute to a great university. I hope that you will feel the strength of that force as you read about the work showcased here.

Tom Sullivan

TOM SULLIVAN

President
University of Vermont

UVM INQUIRY 2017

RESEARCH, SCHOLARSHIP AND THE ARTS
AT THE UNIVERSITY OF VERMONT



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NEW KNOWLEDGE

From black holes in space, to new understandings of the current opioid crisis, University of Vermont faculty members are charting new ground in the knowledge and appreciation of the world around us.



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RELIABLE RENEWABLES

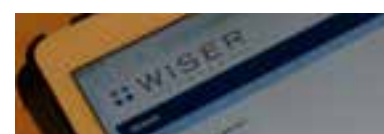
A team of UVM researchers want to balance supply and demand in the nation's electrical grid, one packet of energy at a time.



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UVM faculty members add to the body of knowledge on climate change effects around the world and close to home.



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New knowledge is applied beyond the campus with SPARK-VT, transforming ideas into viable commercial entities.



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Researchers throughout UVM probe the formative years of the human mind.



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For nearly five decades, political scientist and author Garrison Nelson, Ph.D., has found life in legislative archives.



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Life and work at Vermont's university is inextricably linked to the world around it.

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UNIVERSITY OF VERMONT FACTS

THE MISSION OF THE UNIVERSITY OF VERMONT

To create, evaluate, share, and apply knowledge and to prepare students to be accountable leaders who will bring to their work dedication to the global community, a grasp of complexity, effective problem-solving and communication skills, and an enduring commitment to learning and ethical conduct.

HISTORY

The University was chartered in 1791, the same year that Vermont became the 14th state, and celebrated its 225th anniversary in 2016. It was established as the fifth college in New England (after Harvard, Yale, Dartmouth and Brown).

Although it began as a private university, UVM attained quasi-public status with the passage of the Morrill Land-Grant College Act in 1862 and the addition of the State Agricultural College.

Today, the University blends the traditions of both a private and public university, drawing a portion of its general fund from the State of Vermont.

A TRADITION OF EQUALITY

Throughout its history, the University of Vermont has demonstrated its commitment to fairness and equality. It was the first American college or university with a charter plainly declaring that the "rules, regulations, and by-laws shall not tend to give preference to any religious sect or denomination whatsoever."

In addition, the University was an early advocate of both women's and African Americans' participation in higher education. In 1871, UVM defied custom and admitted two women as students.

Four years later, it was the first American university to admit women to full membership into Phi Beta Kappa, the country's oldest collegiate academic honor society. Likewise, in 1877, it initiated the first African-American into the society.



FACULTY

1,600 FULL- AND PART-TIME FACULTY

TOTAL ENROLLMENT

10,267 UNDERGRADUATE
1,462 GRADUATE 461 MEDICAL

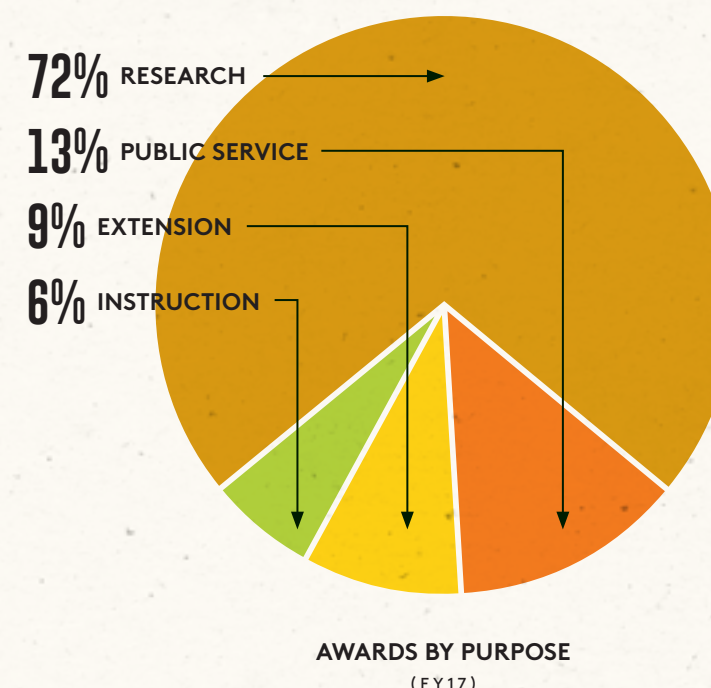
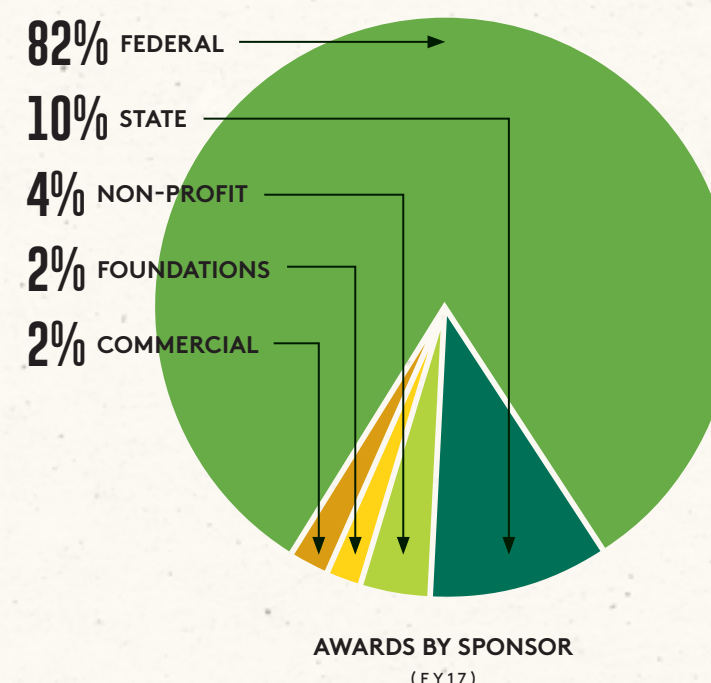
40% UVM UNDERGRADUATE PARTICIPATION IN RESEARCH
(BASED ON 2016 NATIONAL SURVEY OF STUDENT ENGAGEMENT)

GRADUATE EDUCATION

50 MASTER'S DEGREE PROGRAMS 22 DOCTORAL PROGRAMS
1 M.D. PROGRAM 8 INTERDISCIPLINARY GRADUATE PROGRAMS

RESEARCH AWARDS

\$123M TOTAL
715 AWARDS RECEIVED



PHILANTHROPY

The University of Vermont Foundation, in partnership with the UVM Medical Center Foundation, secured a record in total new commitments pledged during the fiscal year that concluded on June 30, 2017. This marked the fourth year in a row that the UVM Foundation has set a new record for total commitments to support the University of Vermont and the UVM Medical Center.

Move Mountains: The Campaign for The University of Vermont was publicly launched in October 2015 to support the four strategic areas of focus at UVM — student access and affordability, faculty support and endowments, new and renovated facilities, and academic and program support. Total commitments to the campaign, which is set to conclude on June 30, 2019, have as of September 2017 surpassed \$439 million towards the overall goal of \$500 million.

\$467M UVM ENDOWMENT (FY16)

\$135.7M NEW FUNDRAISING COMMITMENTS TO UVM (FY2017)

\$439,172,103

MOVE MOUNTAINS CAMPAIGN
(TOTAL AS OF SEPTEMBER 1, 2017)

61,199 CAMPAIGN DONORS
(AS OF JUNE 30, 2017)


moveMountains
The Campaign for The University of Vermont

EXPLORE MORE ABOUT THESE STORIES AT: UVM.EDU/INQUIRY

From Black holes to Helium Atoms

A team of scientists co-led by UVM physicist **Adrian Del Maestro, Ph.D.**, has discovered that a law controlling the bizarre behavior of black holes in deep space also governs the behavior of cold helium atoms that can be studied in laboratories. "It's called an entanglement area law," says Del Maestro. That this law appears at both the vast scale of outer space and at the tiny scale of atoms, "is weird," Del Maestro says, "and it points to a deeper understanding of reality." The study, published in *Nature Physics* in March 2017, may be a step toward



Adrian Del Maestro, Ph.D.

a long-sought quantum theory of gravity and new advances in quantum computing. This research has implications for some

fundamental problems in physics, including the possibility of someday understanding gravity within the realm of quantum mechanics.

THE VALUE OF LAKE CHAMPLAIN'S BEAUTY

Research presented in the summer of 2016 by **BRIAN VOIGT, PH.D.**, of UVM's Gund Institute, in association with the Lake Champlain Basin Program, puts a hefty price tag on Lake Champlain's natural beauty. According to the study, Vermont lakeside communities would lose \$16.8 million in economic activity and 200 full-time jobs — in July and August alone — for every one-meter decrease in water clarity. The study is the first to investigate the relationship between home prices, tourism, and Lake Champlain's visual appearance, which is regularly impacted by algae blooms, nutrient runoff, sewage, and other pollutants.

Crunching five years of data, Voigt and his partners found that lake-related tourism — including restaurants, hotels and recreation services — faces a \$12.6 million drop in direct summer expenditures for every meter decline in water clarity. The team also estimated how lake amenities impact home prices in lakeside counties. Using Vermont tax data, they found a one-meter drop in water clarity yielded a 37 percent depreciation for seasonal homes, and a three percent loss for year-round single-family homes.

"These findings show that water quality in Lake Champlain and its surrounding basin is more than just an environmental concern," says Voigt. "It's a major economic issue that affects homeowners, businesses, and jobs."

THE BIG CHEESE IN FOOD REFERENCE



CATHERINE DONNELLY, PH.D., a professor in the UVM Department of Nutrition and Food Sciences, won a 2017 James Beard Foundation award in April for her encyclopedic reference work, *The Oxford Companion to Cheese*, published in November 2016 by Oxford University Press. The book won in the reference and scholarship category. The James Beard Foundation awards are the culinary industry's most prestigious recognition program. Four years in the making, *The Oxford Companion to Cheese* contains 855 entries from 325 contributors in 35 countries. Donnelly devised all of the 855 categories the entries cover — ranging from cheese regulations and cheese-making techniques to cheese history and cuisines — established the geographically diverse 12-member editorial board that selected many of the contributors and solicited entries, worked directly with numerous contributors herself, and edited all the entries, which are signed by the contributors.

"The goal was to reach out to the global cheese community to find experts who were passionate about the cheeses of their country or region and to bring that expertise and passion to the book," Donnelly says.



"Untitled, Vermont." 1937. Photograph by Arthur Rothstein from *Ground*, published by Daylight Books.

Connections to the New Deal Landscape

Ground: A Reprise of Photographs from the Farm Security Administration, a project by photographer and UVM Professor **Bill McDowell, M.F.A.**, earned accolades as one of 2016's top publications. *Mother Jones* included *Ground* on its list of standout photo books of 2016, and *ArtNet News* placed the volume among its top 10 art books of 2016. McDowell's book brings together photographs from the New Deal's Farm Security Administration (FSA), an effort that employed famed photographers such as Walker Evans and Dorothea Lange. But the photos collected in *Ground* never saw publication at the time. Rejected by an FSA bureaucrat, the negatives were invalidated with a hole punch.

The black circle created by that hole when a print was made — like a black sun

over a summer field or a rude intrusion placed squarely over a farmer's face — piqued McDowell's interest. "I found that there were so many of them that were intriguing images because they were simultaneously representational and abstract," McDowell says. "This black hole created an abstraction and a really palpable tension."

Whereas the intact FSA photos only deal with the past, in McDowell's opinion, the killed photos connect with our age through that black circle. "It got me thinking about the parallels between the time that we live in and the Great Depression and post-Depression times. There are some chilling parallels in terms of the impact on the average person in society," he says.

The Power of Spider Silks

The stuff of spider webs is an engineer's dream: spider silks can be stronger than steel at a mere fraction of weight, and can be tougher and more flexible too. These silks also are nearly invisible to the human immune system. Some even inhibit bacteria and fungi, making them potentially ideal for surgery and medical device applications. However, exploitation of these natural marvels has been slow, due in part to the challenges involved in identifying and characterizing spider silk genes. Now a team of researchers including UVM biologist **Ingi Agnarsson, Ph.D.**, has



made a major advance with the largest-ever study of spider silk genes.

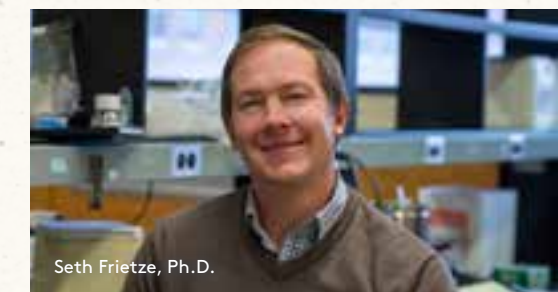
As they reported in May in *Nature Genetics*, the scientists sequenced the full genome of the golden orb-weaver spider (*Nephila clavipes*), a prolific silk-spinner that turns out to produce 28 varieties of silk proteins. In addition to cataloging new spider silk genes, the researchers discovered novel patterns within the genes that may help to explain the unique properties of different types of silk.

"Spider silk is much more complex than we previously thought," says Agnarsson, an expert on spider silk biomechanics. He and his colleagues discovered that "most silk fibers seem to be composed of a mosaic of multiple proteins rather than a single or a few genes underlying each specific silk," he says. This gives spiders many options. "By rearrangements of 'motifs' through evolutionary time, and differential expression patterns in real time," Agnarsson says, "a vast arsenal of different silks are at a given spider's toe-tips."

OFFERING HOPE FOR MORE EFFECTIVE LEUKEMIA TREATMENT

The discovery of a protein signature that is highly predictive of leukemia could lead to novel treatments of the leading childhood cancer, according to a study by **SETH FRIETZE, PH.D.**, assistant professor in medical laboratory and radiation sciences, published this spring in the journal *Nature Immunology*. Frieze and his colleagues found that competition among certain proteins causes an imbalance that leads to leukemia. The new study reveals that the activation of a protein known as STAT5 causes competition among other proteins that leads to acute lymphoblastic leukemia (ALL). If a drug could be developed to prevent the initial activation of STAT5 and restore the natural balance of proteins, ALL could potentially be treated more effectively.

"The major outcome of this story is that a signature emerged from looking at the level of activated proteins compared to other proteins that's very predictive of how a patient will respond to therapy," says Frieze. "That's a novel finding. If we could find drugs to target that activation that could be an incredibly effective way to treat Leukemia."

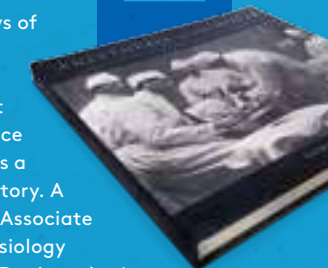


Seth Frieze, Ph.D.

THE BOOKSHELF



From the earliest days of the "ether cone," to modern techniques tailored to the tiniest of infants, the practice of anesthesiology has a rich and nuanced history. A new book from UVM Associate Professor of Anesthesiology **JOSEPH KREUTZ, M.D.**, *Anesthesia at the House*, chronicles the development of the specialty at UVM. The project was no small undertaking: Kreutz spent the better part of a decade researching and writing the illustrated history. He combed through archives and special collections at UVM and UVM Medical Center, and interviewed more than 20 surviving members of the department. The result is a detailed history of anesthesiology at UVM, from the early 1800s up until the present day.



Discovering Disparities in Policing

A 2017 study by UVM economist **Stephanie Seguino, Ph.D.**, revealed notable disparities in how police officers from 29 departments across Vermont treat drivers by race. The research finds racial disparities in traffic stops, searches, arrests and outcomes — which vary by police agency. It is the first study of statewide traffic policing and race, covering Vermont's largest police departments, and follows a 2014 state law requiring police to collect race data. The study is the largest to date on Vermont police and race, and the first to compare data across multiple departments. At the state level, Black and Hispanic drivers were searched approximately three to four times the rate that White drivers were searched. Despite lower search rates, White and Asian drivers were more likely to be caught with serious contraband leading to citations or arrests. Given their shares of the driving population, Black and Hispanic drivers were stopped more than expected, while Asian and White drivers were stopped at rates below their shares of the driving population.



Stephanie Seguino, Ph.D.

“Search and hit rates are among the best available indicators of racial disparities in policing,” says Seguino, who co-authored the study with Nancy Brooks, Ph.D., of Cornell University. “Given that Black and Hispanic

drivers are searched more, but found with less contraband, it suggests police use a lower threshold of evidence for these searches. It also points to potential inefficiencies in policing.”



Read the full study and listen to a podcast of the press conference presenting the report at UVM.EDU/INQUIRY

Ending “Otherhood” for Adults with Autism

Nearly 5 million Americans are believed to have autism spectrum disorder (ASD), with many, after years of feeling friendless and socially isolated, attempting to self-diagnose. A study by College of Nursing and Health Sciences Assistant Professor **Laura Lewis, Ph.D., R.N.**, in the journal *Archives of Psychiatric Nursing* explores the experiences of this often-ignored population to help adults struggling with the neurodevelopmental disorder and help healthcare workers identify adults with ASD before they become depressed or harm themselves.

“Healthcare professionals must have an understanding of self-diagnosis to help individuals transition to formal diagnosis and to adequately educate, support, and screen this population,” says Lewis. “Without knowledge of their diagnosis or supports in place, this undiagnosed population is likely at a higher risk of depression, anxiety and suicide.”

“I wanted to serve as a microphone to voices that were not being heard,” says Lewis. “I hope this research helps professionals and the public understand that, first of all, this group of individuals

who are self-diagnosed exists; second, that their experiences and self-perceptions should not be dismissed; and finally, that healing

is possible through understanding and awareness, whether that is facilitated by a professional diagnosis or not.”

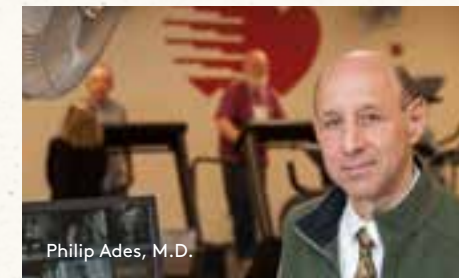


Laura Lewis, Ph.D., R.N.

Cardiac Rehab Roadmap

More than two million Americans experience some type of a cardiac event every year. Whether they've had a heart attack or coronary revascularization procedure, such as bypass surgery or coronary stent placement, doctors typically recommended these patients participate in Cardiac Rehabilitation as outpatients. But despite the proven benefits of increased longevity and reduced hospitalizations with CR, only 20 to 30 percent of eligible patients actually participate.

Why are the rates for this comprehensive secondary prevention program so low? And how can they be improved? An article published in November 2016 in the *Mayo Clinic Proceedings* by lead author **Philip Ades, M.D.**, professor of medicine at the UVM Larner College of Medicine and associate director of the Vermont Center on Behavior and Health, offers answers and solutions. Written by participants of the



Philip Ades, M.D.

Cardiac Rehabilitation Collaborative, the paper identifies ways to increase participation rates to at least 70 percent among eligible patients — an outcome that, if adopted nationwide, could save 25,000 lives and reduce hospitalizations by 180,000 annually.



Watch video of Dr. Ades explaining the study at UVM.EDU/INQUIRY

Fiction Becomes Fact when Entertainment Affects Politics

New research by **Jack Gierzynski, Ph.D.**, UVM political science professor, reveals that the fiction we watch influences our gendered perceptions of what it takes to be an effective leader. The number of roles for strong women has grown in the stories we're watching — think Rey from *The Force Awakens* and Katniss from *The Hunger Games* — expanding beyond the limited portrayals of female characters of the past. And these changes are likely to have ramifications on our political landscape, says Gierzynski. His study, conducted with help from students in his “Political Effects of Entertainment Media” seminar, used clips from *The Hunger Games*, *Doctor Who*, *Star Trek*, and *Battlestar Galactica*, in which characters

exhibited either stereotypically male or female leadership traits, each with positive outcomes. Results showed that after watching these clips, viewers valued female leadership traits (like compassion and empathy) over male traits (decisiveness and self-confidence).

Ultimately, the study adds to growing proof that what we watch has deep impact on how we think. Gierzynski's work, including his popular book about the effect of Harry Potter on Millennial support of Barack Obama in 2008, is grounded in narrative transportation theory, which suggests that when we become immersed in a story, and begin to engage with it as if it were real, it changes us — and our understanding of the world.



THE COSTS OF ELEPHANT POACHING

In Africa, tens of thousands of elephants are killed by poachers each year. A study by **BRENDAN FISHER, PH.D.**, of UVM's Rubenstein School for Environment and Natural Resources has shown that this poaching crisis costs African countries around \$25 million annually in lost tourism revenue. The research, which represents the first continent-wide assessment of the economic losses that the current elephant poaching surge is inflicting on nature-based tourism economies in Africa, was published in November 2016 in the journal *Nature Communications*.

“Conservation is often seen as a luxury,” says Fisher, who co-led the study with colleagues from the World Wildlife Fund and the University of Cambridge. “But our work shows that it pays big to protect elephants.”



THE BOOKSHELF



The two lectures Henry David Thoreau delivered at the Concord, Mass. Lyceum in 1848, which he later gathered together as the extended essay “Civil Disobedience,” have had a lasting effect far beyond what the original audience could have imagined. Thoreau's work has inspired political thought and political action across the globe ever since. **BOB PEPPERMAN TAYLOR, PH.D.**, professor and chair of the UVM Department of Political Science, edited and annotated this edition and provided an introduction which one reviewer called “a model of scholarship.”



How Many Calories in that Tweet?

It's easy to find out how many calories are in a Twinkie. But how about in a tweet? A team of UVM scientists have invented a new instrument for measuring just that: the caloric content of social media posts.

"This can be a powerful public health tool," says UVM's **Peter Dodds, Ph.D.**, who co-led the invention of the new device — called a Lexicocalorimeter — with a team that included several colleagues from UVM's Computational Story Lab. "It's a bit like having

a satellite image of how people in a state or city are eating and exercising." A study of the new device was published in February 2017 in the journal *PLOS ONE*. The Lexicocalorimeter gathers tens of millions of geo-tagged Twitter posts from across the country and fishes out thousands of food words — like "apples," "ice cream," and "green beans." At the same time, it finds thousands of activity-related terms — like "watching TV," "skiing," and even "alligator hunting" and "pole dancing." These giant bags

of words get scored — based on data about typical calorie content of foods and activity burn rates — and then compiled into two measures: "caloric input" and "caloric output."

The ratio of these two measures begins to paint a picture that might be of interest not just to athletes or weight-watchers, but also to mayors, public health officials, epidemiologists, or others interested in "public policy and collective self-awareness," the team of scientists write. The study suggests that the Lexicocalorimeter could provide a new — and real-time — measure of the U.S. population's health. And the study shows that the device's remotely sensed results correlate very closely with other traditional measures of U.S. well-being, like obesity and diabetes rates. For the study, the team of scientists explored about 50 million geo-tagged tweets from 2011 and 2012 and report that "pizza" was the dominant contributor to the measure of "calories in" in nearly every state. The dominant contributor to calories out: "watching TV or movies."



Visit the Lexicocalorimeter at
UVM.EDU/INQUIRY

THE NEXT STRETCH IN CONDUCTIVITY

Try bending your iPhone in half. Or roll up your tablet like a scroll. Or wrap a touchscreen TV around a pole. Doesn't work out so well? That's because the ceramic material used to make many of today's touchscreens has only two of three needed qualities: it's conductive, it's transparent — but it's not flexible. But UVM Professor of Mechanical Engineering **FREDERIC SANSOZ, PH.D.**, and a team of other scientists have made a discovery that may change that. Working with silver at a vanishingly small scale — nanowires just a few hundred atoms thick — they discovered that they could make wires that were both super strong "and stretchy like gum," Sansoz says. They reported their findings in the April 2017 issue of the journal *Nature Materials*.

Such a form of silver wire could be fashioned into a mesh that conducts current, allows light to shine through — and bends so easily "you might be able to tie your smartphone into a knot," he says. The team's new discovery should give chemists and industrial engineers a target size for creating silver wires that could lead to the first foldable phones.



Keri Bryan Watson

The Value of Floodplains

A study by **Keri Bryan Watson**, a Ph.D. student in UVM's Gund Institute and the Rubenstein School of Environment and Natural Resources, has shown that wetlands and floodplains protected Middlebury, Vt., from as much as \$1.8 million in flood damage during Tropical Storm Irene in 2011. The study is the first to calculate the economic benefits that river wetlands and floodplains provided during the major storms that have struck the U.S. East Coast in recent years. Watson and her colleagues analyzed ten flood events to estimate the value of the Otter Creek floodplain near Middlebury. They found the natural barrier saves the town up to 78 percent of potential damages, or up to \$450,000 per year on average.

"These findings show the huge benefits of 'natural infrastructure,'" says Watson.

A Louisiana native, Watson's childhood home bordered a floodplain. She witnessed small local flooding events, and followed

the effects of Hurricanes Katrina and Rita closely. This personal connection drove her to investigate the financial benefits of natural flood barriers, as global flood risks grow due to climate change and development. Among the threats to floodplains are the straightening of rivers to keep water away from new residential and business developments. These actions — often to mitigate flooding risk in one area — can wreak havoc on downstream communities. Events like Irene highlight these consequences, she says.

"It's really a problem of regional coordination, of understanding that everything that happens upstream can affect towns downstream," says Watson, who conducted the study with UVM's **Taylor Ricketts, Ph.D.**, **Gillian Galford, Ph.D.**, and **Jarlath O'Neil-Dunne, M.S.**, with **Stephen Polasky, Ph.D.**, of the University of Minnesota. Their findings were published in *Ecological Economics* in October 2016.

Linking Opioid Abuse to Childhood Trauma

A study by UVM researchers published in March in the journal *Addictive Behaviors* has revealed a link between adult opioid misuse and childhood emotional abuse, a new finding that suggests a rethinking of treatment approaches for opioid abusers. Earlier research has found that a high percentage of

adults who abuse substances were maltreated in a variety of ways as children. But few previous studies have investigated the causes of opioid addiction specifically, and no earlier ones narrowed the link among opioid users to emotional abuse.



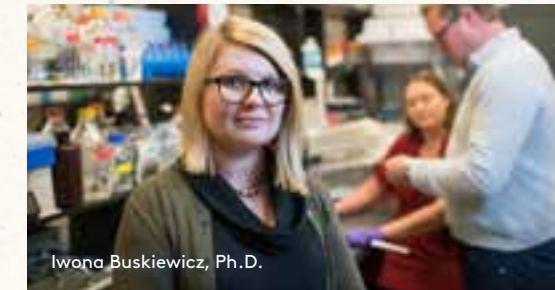
"If a person is being physically or sexually abused, it's easier to put the blame on the person doing the abuse," said **Matthew Price, Ph.D.**, assistant professor in UVM's Department of Psychological Science and the paper's senior author.

"With emotional abuse, the abuser is saying 'You are the problem.' Being called names, being told you're not good enough, being told no one cares about you, undermines your ability to cope with difficult emotions. To protect themselves from strong emotions and from trauma cues that can bring on PTSD symptoms, people with this kind of childhood experience frequently adopt a strategy of avoidance, which can include opioid use." The findings suggest why some opioid abusers don't respond to substance abuse counseling or PTSD treatment and point the way toward potentially more productive therapies.

A POTENTIAL KEY TO AN ALTERNATIVE LUPUS TREATMENT

Only one new drug has become available over the past 50 years for the estimated 1.5 million Americans and five million-plus people worldwide with the chronic autoimmune disease lupus. But new research has identified a previously unknown mechanism involved in the immune response that could provide an alternative therapy target.

Lupus is marked by elevated levels of type I interferon, a substance normally secreted by immune cells in response to viral infections. The origin of the interferon signature in lupus has remained a mystery for years. While working to solve this enigma, researchers, including **IWONA BUSKIEWICZ, PH.D.**, and **ANDREAS KOENIG, PH.D.**, assistant professors of pathology and laboratory medicine at the UVM Larner College of Medicine, uncovered an unexpected finding: a protein that normally signals an immune system pathway during viral infections was spontaneously activated in lupus patients, even in the absence of viral infection. Their results were published in November 2016 in the journal *Science Signaling*. Buskiewicz and her colleagues believe that it might be possible in the future to target this protein therapeutically as a potential treatment.

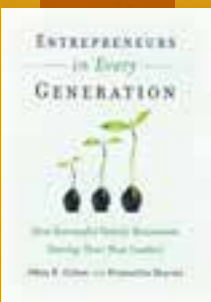


Iwona Buskiewicz, Ph.D.

THE BOOKSHELF



Family-owned businesses are a unique category — run by the closest kind of close-knit groups, but in need of many of the same leadership and entrepreneurial skills in practice in other business models. Professor and Sanders Chair of Family Business **PRAMODITA SHARMA, PH.D.**, and her co-author explore how family-run enterprises, without the hire-and-fire capabilities of other firms, can still keep their original entrepreneurial spirit alive. The chair of Harvard's Family Business Program called this book "a highly insightful, clear, and pragmatic argument that innovation in family companies is essential for multigenerational success."



Saffron on Snow?

Vermont is famous around the globe for its maple syrup, cheese and craft beer. Soon, the state could add saffron to that list. Saffron? In Vermont?

UVM scientists think so. **Margaret Skinner, Ph.D.**, research professor of plant and soil science, and **Arash Ghalehgalabbebahani, Ph.D.**, a visiting post-doctoral associate from Iran, started an experiment growing almost 24,000 of the crocus plants that produce saffron, the world's highest-valued spice, known for its unique flavor and fiery-red hue. Housed in a St. Albans high tunnel — a greenhouse-like domed structure that typically uses no heat or electricity — the plants thrived,

even through the Vermont winter. In the fall, they delivered almost four times as much saffron per square meter as the average yield in Iran, the largest saffron-producing country, and more than twice that of the next-largest producer, Spain, according to Ghalehgalabbebahani.

"We did it," Skinner says. "We got higher yields than are reported in saffron-growing areas. So we've proven that, yes, it can be done."

Based on the current retail price of about \$19 per gram, the researchers estimate that saffron could



Margaret Skinner, Ph.D. and Arash Ghalehgalabbebahani, Ph.D.

potentially generate revenue of about \$100,000 per acre — which would make it Vermont's most lucrative greenhouse-grown crop.

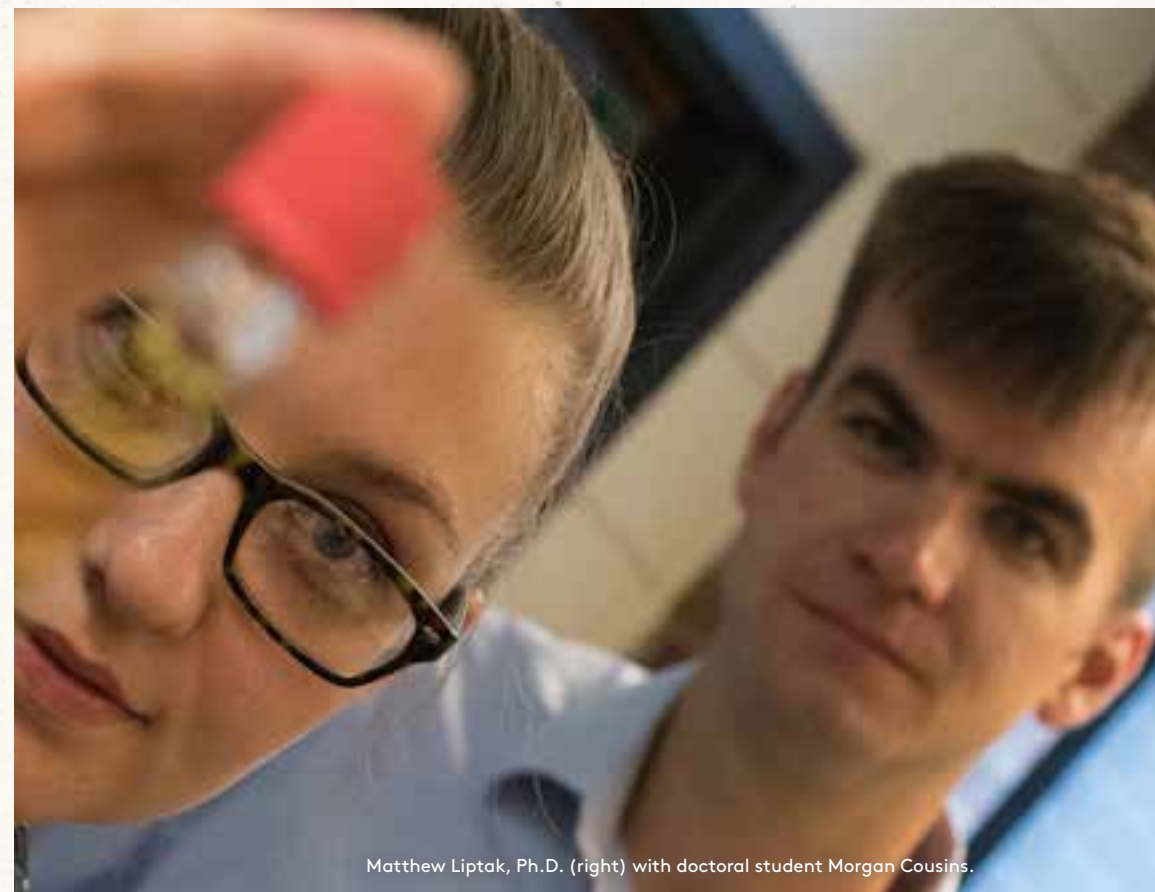


TAKING THE TEMPERATURE OF THE WAR ON TERROR

If the present administration hopes to pressure Muslim states into supporting the U.S. Global War on Terror, they would be wise to consider the latest findings of **PETER HENNE, Ph.D.**, UVM assistant professor of political science. Henne, who joined the UVM faculty in 2016 after working on the staff of the Pew Research Center, analyzes issues critical to our internationally volatile era in *Islamic Politics, Muslim States and Counterterrorism Tensions*, published by Cambridge University Press.

Among the Henne's key assertions: Muslim states with closer ties between religion and state have been historically less cooperative on counterterrorism, even when a variety of alternate explanations and variables were taken into consideration.

Henne notes that within a number of Muslim states it has been a decades-long domestic struggle to determine the proper relationship between Islam and politics. "Discrete U.S. policies are unlikely to change this," Henne says, "and the United States may need to choose between investing in complex, long-term efforts or scaling back its ambitions for the region."



Matthew Liptak, Ph.D. (right) with doctoral student Morgan Cousins.

Let There Be Light, in a New Form

Glow-in-the-dark stickers, weird deep-sea fish, LED lightbulbs — all have forms of luminescence. In other words, instead of just reflecting light, they make their own. Now a team of scientists from UVM and Dartmouth College have discovered a new way that some molecules can make a luminescent glow — a strange, bright green whose production contradicts what had seemed to be an immutable chemical law on molecular light production.

"It's a new method to create light," says **Matthew Liptak, Ph.D.**, a UVM chemist who co-led the research. The new light may have many promising applications including novel kinds of LED bulbs and medical dyes "that can sense viscosity within a cell," he says. The discovery was reported in September 2016 in the journal *Nature Chemistry*.



Christine Vatovec, Ph.D.

Drugs in the Water? Don't Blame Students.

With nearly sixty percent of American adults now taking prescription medications, there is growing concern about how many drugs are flowing through wastewater treatment facilities and into rivers and lakes. Scientists have assumed that people flushing their unused medications down the drain or toilet was a major source of these drugs in the water. But a new first-of-its-kind UVM study tells a different story.

"Less than one percent of students we surveyed report flushing any drugs down the drain in the last year," says UVM scientist **Christine Vatovec, Ph.D.** And what she and her colleagues found in the water backs up the students' self-reporting.

Vatovec co-led a team of five scientists from UVM and the United States Geological Survey who sampled wastewater outflow in Burlington for ten days during the spring when students from UVM were moving out. They detected 51 pharmaceuticals pouring into Lake Champlain — and they expected to see a spike in concentrations of some of these drugs as students dumped unused meds down the drain while they were departing their dorm rooms and apartments. But they didn't see it.

"This contradicts the common assumption that down-the-drain disposal is an important source of pharmaceuticals to the wastewater stream in the environment," the team wrote in their study, published in August 2016 in the journal *Science of the Total Environment*.

EXPLORING SOCIETY'S MARGINS

JONAH STEINBERG, Ph.D., associate professor of anthropology and director of Global Studies at the University of Vermont, is using a three-year, nearly \$300,000 grant from the Cultural Anthropology Program at the National Science Foundation (NSF) to research how groups at the margins of society interact in the very diverse city of Marseille, France. It is Steinberg's second single-investigator NSF grant since arriving at UVM in 2006. Steinberg is investigating how marginalized groups, including refugees and Romani people, co-exist in marginal urban spaces like highway underpasses, urban forests, and abandoned lots.

"Marseille is interesting because you have this ethnic mix of Romani people and relative newcomers, like refugees from conflicts in the Middle East, who are living and interacting on the periphery of the city," Steinberg says. He hopes, through immersive observation, to see how changes in an already diverse landscape play themselves out in real time. "It's really about how societies and states treat people they deem 'outsiders,'" he explains, "and how those 'outsiders' react creatively through mobility, defiance, and survival strategies of their own."



Improving Diagnosis for MS

While it has been known for decades that misdiagnosis of multiple sclerosis (MS) is a problem, there have been no large studies to help better understand the disorders mistaken for MS and the possible reasons for why they are misdiagnosed. A study by researchers including UVM's **Andrew Solomon, M.D.**, published in the journal *Neurology* in August 2016, provides that guidance. The research involved 24 MS specialist neurologists at UVM, Mayo Clinic, Washington University, and Oregon Health & Science University.

"While there may be different reasons for misdiagnoses by subspecialists, [this research] suggests that we all make mistakes,



Andrew Solomon, M.D.

and can do better," says Solomon, who hopes the study will encourage better education of clinicians on the proper use of MS diagnostic criteria, and further study of how to recognize patients incorrectly diagnosed with MS.

THE BOOKSHELF



Professor of Spanish **TINA ESCAJA, Ph.D.**, has made her mark at UVM as a teacher and scholar, recognized by her Kroepsch-Maurice Excellence in Teaching Award, a Dean's Lecture Award for excellence in teaching and research, and by UVM's University Scholar Award for 2015–16. Escaja's latest poetry collection, *Manual Destructivista*, was listed in the *Latino Book Review* "Top Ten Bilingual Poetry Books" feature for National Poetry Week in 2017.



Examining Resurgent Progressives

University of Vermont Professor **Jon Erickson, Ph.D.**, has never been a fan of the status quo. As an ecological economist, his national and international scholarship has challenged the core assumptions of mainstream economics. As a social entrepreneur, he has helped build interdisciplinary research-to-action collaborations between academic, government and civil society partners. Now as an up-and-coming independent filmmaker, he's gauging the strength a new era of progressive politics in America he thinks may be waking at just the right moment to seed the social movement of a generation.

Erickson's feature-length documentary "Waking the Sleeping Giant: the Making



of a Political Revolution" chronicles the growing strength of the American progressive movement. Erickson wrote, directed and filmed the documentary over the last three years with former Senate staffer Jacob Smith, veteran political consultant Kathryn

Goldman, and a team of cinematographers from around the country.

The film has been shown at festivals around the country during the spring and summer of 2017. This is the ninth documentary Erickson has collaborated on during his career.

"Plan Bee" — an App for Farmers

A farmer today who wants to plant wildflowers to nurture the bumble bees that pollinate her crops has a complicated

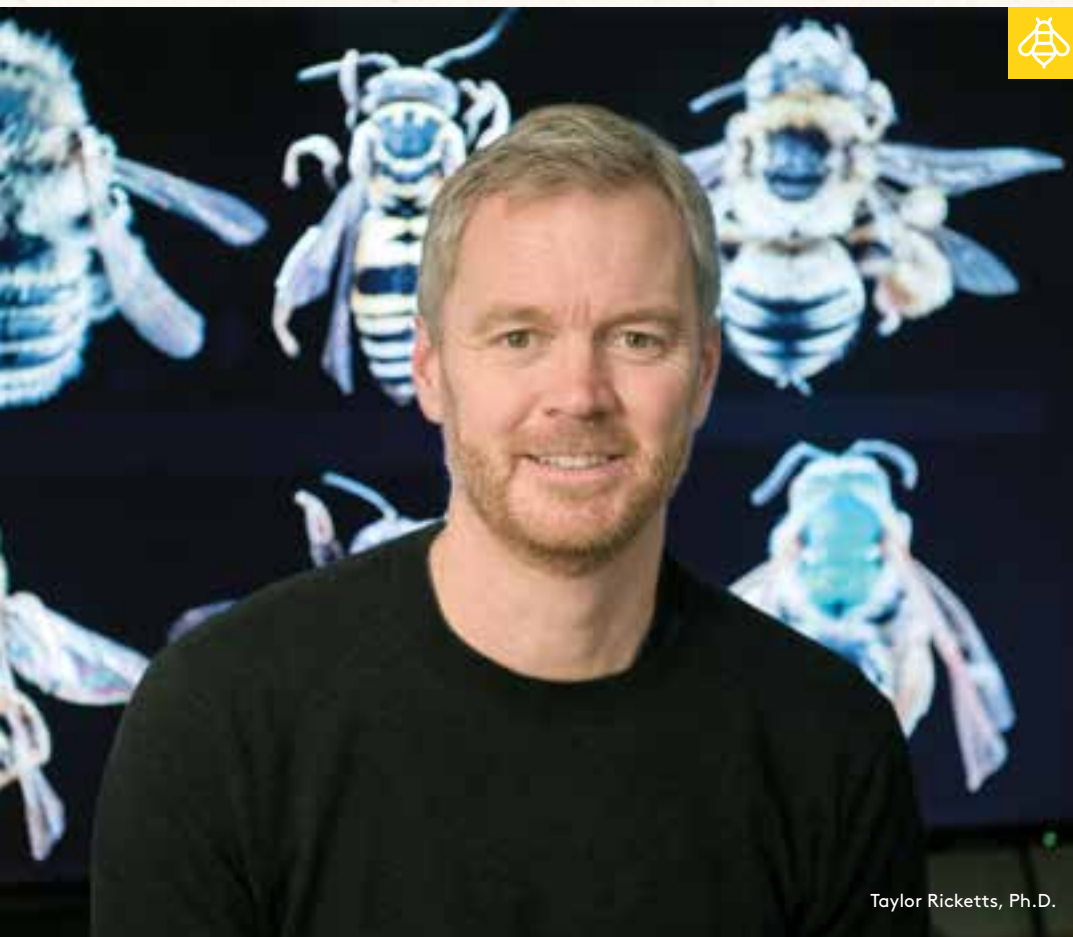
task. Currently, she would have to walk through her fields, assess locations, take measurements, spend hours crunching costs,

and still only guess at the number of bees and pollination the effort will generate. Soon, that farmer could do it all on her phone or computer with a mobile app co-developed by UVM bee expert **Taylor Ricketts, Ph.D.**, that will calculate the crop productivity and pollination benefits of supporting endangered bees. Ricketts introduced the technology at an American Association for the Advancement of Science annual meeting panel in February.

A beta version of the app will allow users to explore land management scenarios, and virtually test how bee-friendly decisions would improve their business, says Ricketts. The app is a product of the Integrated Crop Pollination Project, supported by the USDA NIFA's Specialty Crop Research Initiative.

The app builds on the first national map of U.S. wild bees, which found the key insects are disappearing in the country's most important farmlands — including California's Central Valley, the Midwest's corn belt, and the Mississippi River valley. That study, led by UVM bee researchers, showed that with further bee losses, farmers could face higher costs and the nation's food production could experience "destabilization" due to climate change, pesticides, habitat loss and disease.

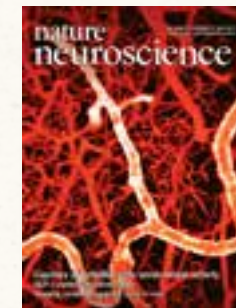
"Farmers are a natural partner to protect bees, because pollinators are essential for growing many foods," says Ricketts, noting that more than two-thirds of the most important crops either benefit from or require pollinators.



Taylor Ricketts, Ph.D.

An Electrical "Switch" in the Brain's Capillary Network

All it takes is the flip of a protein "switch" within the tiny wire-like capillaries of the brain to increase the blood flow that ensures optimal brain function. New research by **Thomas Longden, Ph.D.**, and **Fabrice Dabertrand, Ph.D.**, both assistant professors of pharmacology at the UVM Larner College of Medicine, has uncovered the fact that capillaries have the capacity to both sense brain activity and generate an electrical vasodilatory signal to evoke blood flow and direct nutrients to nourish hard-working neurons. The findings of Longden, Dabertrend, and their UVM colleagues were



reported in *Nature Neuroscience* (an image from the study was used on the cover of the journal).

Understanding the mechanisms that precisely direct cerebrovascular blood flow to satisfy the brain's ever-changing energy needs has, to date, eluded scientists. The UVM team discovered that capillaries actively control blood flow by acting like a series of wires, transmitting electrical signals to direct blood to the areas that need it most.

"These findings open new avenues in the way we can investigate cerebral diseases with a vascular component," says Dabertrand.

Rehab Services Provide Major Help to Medicare Recipients

Research by **Nancy Gell, Ph.D.**, from the College of Nursing and Health Sciences that shows significant patient-reported functional improvement among Medicare recipients who utilize rehabilitation services offers hope for America's 65-and-older population.

The study, published in April in the *Archives of Physical Medicine and Rehabilitation*, was based on an analysis of the 2015 National Health and Aging Trends Study. It found that among the approximately eight million Medicare beneficiaries who received rehabilitation in 2015, 72 percent reported functional improvement following

physical, occupational or speech-language therapy rehabilitation. Approximately 75 percent reported meeting their personal goals by discharge.

"Understanding rehabilitation services use is essential to plan for sufficient resources for the projected doubling of the older adult population, from 43.1 million in 2012 to an estimated 83.7 million by 2050," says Gell, who is also a physical therapist. "Loss or reduction in this benefit as currently provided by Medicare may result in worse health outcomes and more health care expenditures."



"Ideathon" Entry Helps Student Voters

The winning entry in the University of Vermont's first "ideathon" is a pocket guide that will make it easier for UVM students to vote in national elections by providing them with state-by-state information on casting absentee and early mail-in ballots. (Many students at the University are not from Vermont and are registered to vote in their home states.)

The guide was created and developed by **Wyatt Chia**, a Ph.D. candidate in the Cellular, Molecular, and Biomedical Science Program, with help from teammate **Jenn Karson, M.F.A.**, a lecturer in the College of Engineering & Mathematical Sciences.

Ideathons have become popular in recent years as a kind of non-technical version of a hackathon, whose end product is an idea rather than an app. Like hackathons, ideathons harness the power of the group to address a single challenge. UVM's ideathon was inspired by the dismal voter turnout of the 2016 presidential election. Only 55 percent of voting age citizens cast ballots, the lowest rate in 10 years, according to CNN. The event's theme was to create ideas that would encourage more voting. The event attracted about 30 students, faculty and staff to the Hills Building in February to take on the challenge.



HOT PEPPERS AND DECREASED MORTALITY

Like spicy food? If so, you might live longer, say researchers at the UVM Larner College of Medicine, who found that consumption of hot red chili peppers is associated with a 13 percent reduction in total mortality — primarily in deaths due to heart disease or stroke — in a large prospective study published in *PLoS ONE*. For centuries, peppers and spices have been thought to be beneficial in the treatment of diseases, but only one other study — conducted in China and published in 2015 — has previously examined chili pepper consumption and its association with mortality. This new study corroborates the earlier study's findings.

Using National Health and Nutritional Examination Survey (NHANES) III data collected from more than 16,000 Americans who were followed for up to 23 years, medical student **MUSTAFA CHOPAN** from the Larner class of 2017 and Henry and Carleen Tufo Professor of Medicine **BENJAMIN LITTENBERG, M.D.**, examined the baseline characteristics of the participants according to hot red chili pepper consumption.

"Because our study adds to the generalizability of previous findings, chili pepper — or even spicy food — consumption may become a dietary recommendation and/or fuel further research in the form of clinical trials," says Chopan.

THE BOOKSHELF

Professor and Chair of Pathology and Laboratory Medicine **DEBRA G.B. LEONARD, M.D., PH.D.**, broke new ground ten years ago with the initial edition of *Molecular Pathology in Clinical Practice*. In 2016 Leonard edited the new updated and enlarged second edition

of the work from Springer. The text covers all areas of the rapidly expanding field of molecular pathology, including a new section on genomics, which is increasingly becoming a source of foundational medical information for physician decisions.



PROBING THE CONSEQUENCES OF INEQUALITY

When news first broke in 2014 about the Flint, Michigan water crisis, Assistant Professor of Sociology **KATRINELL DAVIS, PH.D.**, was as surprised as the rest of America, but for a different reason: that it took so long for a public health disaster to happen in her hometown. Davis experienced inadequate public services first-hand while growing up in Flint, motivating her to become an expert on how public policy disproportionately affects lower-income communities. Her research examines the intersection of race, gender, and work trends within the American labor market and how they negatively affect working people. "I was looking at this in 2012, well before anyone was concerned about environmental injustice in Flint," says Davis, who is working on a highly anticipated book on the topic. "My research focuses on the life chances of low-skilled poor people living in low-resource communities, so I want my students to understand how these inequalities are created and how they negatively affect working people in cities across America."





“WE’RE DESIGNING A SYSTEM THAT CAN BALANCE THE UPS AND DOWNS OF RENEWABLE ENERGY IN A WAY THAT CAN KEEP THE RELIABILITY WE’VE GROWN ACCUSTOMED TO.”

— PAUL HINES, PH.D.

Reliable Renewables

A TEAM OF UVM RESEARCHERS WANT TO BALANCE SUPPLY AND DEMAND IN THE NATION’S ELECTRICAL GRID, ONE PACKET OF ENERGY AT A TIME.

BY SARAH TUFF DUNN

Paul Hines, Ph.D., the L. Richard Fisher Professor at UVM’s College of Engineering and Mathematical Sciences, shares an office with Homer Simpson. Well, not technically, but a print of the animated cartoon character at work — cooking hot dogs on the control panel at the Springfield Nuclear Power Plant — hangs on the wall of Hines’ office, opposite a whiteboard filled with complicated physics equations.

It’s an apt juxtaposition for Hines, as one of three UVM faculty members whose research has formed the basis of Packetized Energy, a new company that is cooking up a hot-dog approach to a control system for renewable energy resources through complex computations, streamlining the way the world charges and stores electricity.

“I’m working on describing how to manage a battery in a power system,” says Hines of the whiteboard equations, during an interview on the eve of his departure to speak about this new technology at the Grid Edge World Forum in California. “How do you manage batteries best? When do you put power in, or pull power out?”

All are critical questions, as trains will stop, stoplights will fail, and people will become stranded during the massive power outages triggered by improper management of the electrical grid — the network of power lines that distribute electricity to millions of consumers. “It becomes a near doomsday scenario, and it can happen on a regular basis, because the grid is vulnerable,” says Hines. “We’re designing a system that can balance the ups and downs of renewable energy in a way that can keep the reliability we’ve grown accustomed to.”

Growing up in Tacoma, Washington, Hines had a hankering for engineering early on. He tinkered with Legos and was fascinated with how things worked. “Maybe it was rebellion against my parents, who were both English majors — I was going to solve nuclear fusion,” he says with a laugh. “I’ve always been interested

in energy.” Learning how the world runs on power systems and electricity, he was hooked on discovering “how the grid works, and how to move my career in that direction.”

Hines’ scholarly pathway has been firmly linked with the grid. He earned a B.S. in electrical engineering from Seattle Pacific University, and an M.S. at the University of Washington, where his thesis title was “A Power Systems Capstone Design Project and Associated Simulation Software Designed to Meet the Changing Needs of the Electrical Power Industry and Engineering Accreditation Requirements.” That, in turn, gave way to “A Decentralized Approach to Reducing the Social Costs of Cascading Failures,” his dissertation for a Ph.D. in Engineering and Public Policy from Carnegie Mellon University.

It wasn’t until 2011, however, that Hines took these topics to a new level by brainstorming ideas with **Jeff Frolik, Ph.D.**, a fellow UVM professor and Fulbright Distinguished Chair in the Department of Electrical and Biomedical Engineering, who had been studying how to manage wireless sensor networks. “We developed a way to take this algorithm and apply it to power,” says Hines, adding that the next key development was Assistant Professor **Mads Almassalkhi, Ph.D.**, suggesting that they could extend this theory to other applications — such as water heaters, air conditioners, and batteries.

“So now we’re taking these core computational algorithms and applying them to lots of different things that might get plugged into the grid,” says Hines, “so that we can run everything without blowing up the grid.”

The nationwide power grid — which can only transmit electricity, not store it — is experiencing a period of rapid change, he adds, thanks to the addition of wildly fluctuating wind and solar power sources coming into a system designed for much more stable, predictable nuclear and coal power plants. Put them

Opposite: L. Richard Fisher Professor Paul Hines, Ph.D., and his colleague, Professor and Fulbright Distinguished Chair Jeff Frolik, Ph.D.

all together, and you get a grid in crisis. Also seesawing is the price of electricity, which can go from 2 cents per kilowatt hour on a “normal” day to up to an effective price of \$100 per kilowatt hour on extremely hot summer days. Synchronizing all the elements flowing into the grid has tremendous value. Instead of managing the supply of electricity at the level of the enormous, sprawling grid, the Packetized device puts supply management right in individual homes and businesses.

That’s what guided Hines, Frolik, and Almassalkhi when they co-founded Packetized Energy in 2016, with the basic aim to take their research and use it to build a software platform to connect electricity customers and suppliers in a much more systematic fashion.

“In very simple terms, the technology we are developing, producing, and commercializing aggregates and coordinates a fleet of energy resources that sit in people’s homes — in basements and closets — that people do not interact with, but use every day,” explains Almassalkhi. “By doing so, we’re able to offer valuable services to utilities and other energy market participants at the very highest level.”

On the screen of his MacBook Pro, Hines brings up a dot-filled diagram showing electrical power usage in Poland. Connect the dots as an example of the scholarship he and his colleagues



have undertaken, and the resemblance of a circulatory system emerges — an alien system, perhaps, one that pumps a different sort of electronic blood to different, unfamiliar body parts. It’s a view of the world that has shaped the dozens upon dozens of peer-reviewed journal articles, book chapters, policy reports, conference papers, and presentations they have authored and co-authored.

Putting these words into action, however, is the mission of Packetized Energy. The groundwork for this was laid even before the company’s founding, thanks to the foresight of Almassalkhi, who joined the UVM faculty in August of 2014 and was soon putting together a proposal for the Department of Energy (DOE). “As young faculty, you seek funding, so you come up with crazy ideas,” he says, explaining how he reached out to the Advanced Research Project Agency — Energy (ARPE) with the underlying concept for Packetized Energy. Because the DOE’s ARPE requires a commercialization path for approved projects upon completion of a three-year grant, Almassalkhi drafted a basic business plan in his proposal.

ARPE responded with \$1.7 million in funding for UVM’s Packetized Energy Management project, to run from mid-2016 through 2019. Instead of waiting for 2019, though, the Packetized Energy team was able to step outside of the standard ARPE template. “It’s a highly competitive program, so we realized we were onto something special,” he says. “We looked at the market, and the competing technology, and we realized we needed to strike very early.”

Their mobilization was swift. They hired chief engineer and UVM graduate **Andrew Giroux**, and created a website that clearly lays out the premise of Packetized Energy: to design and deploy “human-friendly systems to enable distributed energy sources such as water heaters, electric vehicle chargers, battery storage systems and pool pumps to balance supply and demand in the power grid. As a result, people can better manage their energy costs and the grid can run reliably with renewable energy.” The founders also present the advantages of the patent-pending Packetized Energy Management (PEM): local decision-making, privacy, fairness, scalability, and the ability to be adaptive.

The Packetized co-founders, meanwhile, have learned plenty as they meet the obstacles that can arise from introducing an innovative concept to the renewable energy world. “The biggest challenge has been finding partners that are willing to work with a very small company,” says Almassalkhi, “with enormous promise but a small track record. How do we find partners that are willing to work with us in the same agile way we work?”

Frolik adds that Packetized Energy faces another hurdle: “Demonstrating the full capabilities of the technology requires we have thousands of devices, such as electric water heaters, under management, but that requires a project of that scale to be awarded. So we have a chicken and egg situation.”

At left: Packetized Energy is working to simplify the use of energy from renewable sources such as solar cells. Opposite: Assistant Professor Mads Almassalkhi, Ph.D.



“WE AREN’T THE ONLY COMPANY TRYING TO MATCH ELECTRIC ENERGY DEMAND TO THE AVAILABILITY OF RENEWABLE ENERGY, BUT I BELIEVE WE ARE THE ONLY ONE WITH A SOLUTION THAT CAN SCALE TO MANAGE MILLIONS OF DEVICES IN A WAY IN WHICH CUSTOMERS AREN’T BOTHERED.”

— MADS ALMASSALKHI, PH.D.

That situation was aided this summer when the National Science Foundation (NSF) awarded the company a \$225,000 Small Business Technology Transfer grant. The NSF grant will allow Packetized to more fully explore coordinating large numbers of solar panels and battery storage systems.

LaunchVT is the name of a community initiative powered by the Lake Champlain Regional Chamber of Commerce to recognize local businesses with exposure for their entrepreneurial efforts, and funds to support their efforts.

In May, Packetized Energy received \$15,000 prize money in the competition. “It was a huge win for us,” says Hines, who is using the funds to hire a software developer. More recently, in September, the company won the “Future Formula” pitch at the national Climate Economy Conference. Satisfaction comes in less tangible ways, too, such as fostering the friendships that enable growth. “There are certain risks that companies take to work with small, unknown entities,” says Almassalkhi. “Luckily, Paul, over the last ten years, has established himself as a presence within the power systems community, and we can leverage those relationships.”

Almassalkhi agrees that the LaunchVT recognition was “a fantastic reward,” and a validation of the value of the concept of Packetized Energy Management. “This is just the beginning,” he says. “We have a long road ahead of us.” For his part, Frolik points to the company receiving its first seed investment and that NSF grant. “It’s rewarding seeing others be excited about our approach,” he says. “We aren’t the only company trying to match electric energy demand to the availability of renewable energy, but I believe we are the only one with a solution that can scale to manage millions of devices in a way in which customers aren’t bothered.”

Keeping cool is key, says Hines, especially with the time crunches of serving as full-time professors while moving Packetized Energy forward into the future. A father of two, he likes to hike and bike in the Green Mountains, but much of his free time is spent investigating, estimating and measuring such concepts as cascading failure risk and the impact of network structures on global power use.

So while Homer Simpson may choose his nuclear station to cook hot dogs, Hines and his team are just heating things up. When asked if the three co-founders of Packetized Energy ever enjoy outdoor excursions or other diversions together, Almassalkhi laughs. “We don’t do anything to blow off steam,” he says. “We use steam to push us forward.” **1**



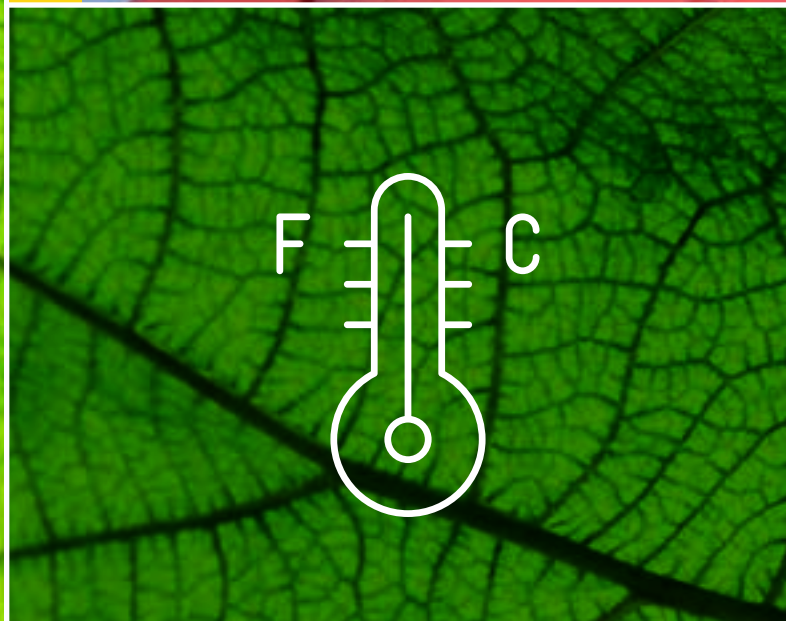
A VISION OF BETTER CARE

As the inaugural recipient of the Outstanding Investigator Award from the National Heart, Lung and Blood Institute, **YVONNE JANSSEN-HEININGER, PH.D.**, professor of pathology and laboratory medicine at the Larner College of Medicine, says this award will facilitate her vision to fully translate her research findings into clinical care. This prestigious award is designed “to promote scientific productivity and innovation by providing long-term support and increased flexibility” in research. Janssen-Heininger will use it to further her already substantial work in antioxidant therapies for the millions of patients with asthma, chronic obstructive pulmonary disease, and pulmonary fibrosis.



“SHARING KNOWLEDGE AND GIVING BACK TO MY COMMUNITY OF SCHOLARS, PEERS, STUDENTS ARE MY TWO AXIOMS IN LIFE. WATCHING STUDENTS MATURE AND FLOURISH IN THEIR FOUR YEARS WITH US IS A GREAT PRIVILEGE AND THE BEST PART ABOUT BEING A TEACHER-SCHOLAR HERE AT UVM.”

— LESLEY-ANN DUPIGNY-GIROUX, PH.D.



Climate of Change

UVM FACULTY ADD TO THE BODY OF KNOWLEDGE ON CLIMATE CHANGE EFFECTS AROUND THE WORLD AND CLOSE TO HOME.

BY JOSHUA BROWN
AND JEFFREY WAKEFIELD

Across the University of Vermont, faculty members are pursuing research and leading initiatives to understand and potentially impact the slow, sure, and perilous changes in the Earth's climate caused by humankind's industrialization of the planet over the last three centuries. The following is just a sampling of the scholarly work and community action taking place that is influenced by this vital and controversial topic.

LEADING ASSESSMENT IN THE NORTHEAST

Lesley-Ann Dupigny-Giroux, Ph.D., chair of the Department of Geography, was named regional lead of the northeast chapter of the fourth National Climate Assessment (NCA4) in November of 2016. Dupigny-Giroux was selected from nearly 200 experts across the United States nominated by their peers to serve as author on NCA4.

David Reidmiller, director of the National Climate Assessment, described her as having “a unique set of qualifications, experiences, and perspectives that will elevate the utility of the Northeast Chapter — and the NCA4 as a whole.”

Gathering and disseminating knowledge are key factors in the professor's life. “Sharing knowledge and giving back to my community of scholars, peers, students are my two axioms in life,” said Dupigny-Giroux in an interview in *Directions* magazine in 2016. “Watching students mature and flourish in their four years with us is a great privilege and the best part about being a teacher-scholar here at UVM.”

The National Climate Assessment is the U.S. Government's premier resource for articulating the risks posed to the nation by climate change, as well as what is being and can be done to minimize those risks. It is an inter-agency effort, bringing together experts from not only the 13 federal agencies of the U.S. Global Change Research Program, but the broader federal government, and hundreds of experts in the academic, non-profit, and private sectors.

Dupigny-Giroux is also the State Climatologist for Vermont. Her work takes her across Vermont to assist colleagues in state agencies dealing with transportation, emergency management, agriculture, and forestry, as well as outreach to the state's legislators, to help plan for and adapt to climate change. She is an expert in floods, droughts, and severe weather and the ways in which these affect Vermont's landscape and people.

In 2016, Dupigny-Giroux was also one of the lead organizers of the 14th Annual Climate Prediction Applications Science Workshop in Burlington. The international conference, launched in 2002 by the National Weather Service's Climate Services Division, brought together a diverse group of climate researchers, climate product developers, and climate information users to share developments in research and applications of climate predictions, with the goal of putting new information and tools in the hands of end-users to improve decision making at all policy levels.

WHAT WE THINK ABOUT CLIMATE

Research published in 2016 by **Meredith Niles, Ph.D.**, of the Department of Nutrition and Food Sciences in the journal *Global Environmental Change* suggests that irrigation systems designed to buffer farmers from the effects of a warming planet may be causing them to think their local area is cooler and wetter than it is — perceptions that other studies suggest may slow their efforts to address climate change. The paper is the first to show the impact of infrastructure on climate perception.

The research compares the climate record since 1980 of two wine producing regions in New Zealand, Marlborough and Hawke's Bay, with resident farmers' perceptions of climate change. Both areas rely heavily on irrigation for growing grapes and other crops.

Opposite: Chair of the UVM Department of Geography Lesley-Ann Dupigny-Giroux, Ph.D. Opposite, bottom right: ice floes on the Greenland coast.



“This study is the first to suggest that infrastructure like irrigation that can help farmers deal with the climate may actually affect how they perceive climate change,” said Niles. “What may have previously been dry pasture is now lush with green leaves and grapes. It’s not surprising that some farmers believe precipitation has increased.”

The findings are especially significant because of their behavioral implications. In an earlier paper, in *PLoS One*, Niles showed that experience with, and belief in, human-induced climate change, was necessary for farmers to want to reduce their greenhouse gas impacts and adopt adaptive strategies. Absent these experiences and beliefs, farmers indicated they would be less likely to make these behavioral changes.

“This could be a significant factor we’re overlooking,” Niles says. “While many of these infrastructure systems are critical to help us adapt and manage the climate, they might also influence how we perceive change. And given that experience with climate change is shown to be a critical factor for behavior change and policy support, this might have profound effects.”

MOUNTAINTOPS, CLEAN WATER, AND CLIMATE CHANGE

Mountains are far more than rocks. They also confer various natural benefits — half the world’s drinking water, for example filters through high-elevation forests, plants, and soils.

Nathan Sanders, Ph.D., — an ecologist at the University of Vermont and director of UVM’s Environmental Program — helped lead a first-of-its kind study, published in the journal *Nature* in February 2017, that shows how these mountain ecosystems around the globe may be threatened by climate change.

Rising temperatures over the next decades appear likely to “decouple” key nutrient cycles in mountain soils and plants, an international team of sixteen scientists reported in the journal.

Their study suggested that this event could disrupt the function of mountaintop ecosystems, as plant communities above and at treeline are thrown into turmoil faster than trees can migrate uphill in a warmer world.

“Humanity relies on mountains,” says the new study that gathered data at treelines in New Zealand, Colorado, Canada, Australia, central Europe, Japan and Patagonia. “We found in all these places that temperature change drives many other kinds of change, potentially disturbing biodiversity, and that could have a profound effect on the ecosystem services mountains provide to people — like clean water.”

The new study overcame a problem researchers have wrestled with for years: that the effects of climate change occur over a much longer time than the duration of traditional scientific experiments.

The study’s predictions are worrisome. For example, “we see that at lower elevations the nitrogen cycle speeds up with warming,” says co-author UVM ecologist **Aimée Classen, Ph.D.** So the scientists expect that global warming will improve the nitrogen nutrition available to mountain plants. However, decreasing elevation did not increase the availability of phosphorus, another key nutrient for plants. In other words, as mountaintops warm, “you’re like to get this disconnect — a decoupling — between the balance of those two nutrient cycles that are needed to build plant materials,” Classen says. Over decades and centuries, this lost balance between nitrogen and phosphorus could “slow productivity” of mountaintop ecosystems, threatening their health and the downslope benefits they provide to other plants, animals, and people.

“All the climate models assume that plants can just march up the mountains as it gets warmer,” says Classen, an associate professor in the Rubenstein School of Environment and Natural Resources. “But this study shows that march might not be so easy.”

“This study looks at mountains to show how ecological linkages can become unlinked with climate warming,” says UVM’s Nathan Sanders, “and shows that it’s a global phenomena.”

GREENLAND ON THIN ICE?

The ice sheet covering Greenland is four times bigger than California — and holds enough water to raise the global sea level more than twenty feet if it were to melt. Today, sea levels are rising, and the melting of Greenland is a major contributor. UVM geologist **Paul Bierman, Ph.D.**, from the College of Arts and Sciences and his students have traveled to this remote island many times, seeking to better understand: how fast could Greenland melt in a warming world?

Bierman’s latest study, published in December 2016 in the journal *Nature*, provides powerful insight into this question — and generated media stories around the world, including in *TIME* magazine, *Scientific American*, the BBC, *Popular Science*, Agence France-Presse, and many other outlets.

“The melting we are seeing today,” Bierman says, “may be out of the bounds of how the Greenland ice sheet has behaved for many millions of years.”

To make better predictions about the future of the ice sheet, Bierman and other scientists have tried to understand its past, hoping to glean what the ice was doing millions of years ago when the Earth was three or more degrees Fahrenheit warmer than it is now. But their understanding of the ice sheet’s complex behavior before about 125,000 years ago has been fragmentary at best.

Bierman’s *Nature* study — performed with one of his students and a team of other scientists — was paired with another study in the journal. Both applied an innovative new technique: using radioactive isotopes found in quartz to estimate how long the island’s bedrock was exposed to the sky versus buried under the ice. This approach allowed the scientists to peer into the deep history of the Greenland ice sheet, looking



back millions of years farther than previous techniques allowed. But the new, deeper view raised an important scientific debate about the ice sheet’s behavior, which played out in media coverage after their publication.

“We must recognize the importance of advancing polar science to understand how our world works. And, right now, because we’re pumping huge plumes of greenhouse gases into the atmosphere, we really need to know how our world works,” Bierman says.

CLIMATE CHANGE AND LAKE CHAMPLAIN

Closer to home, new research published in the journal *Environmental Research Letters* in November 2016 suggests that Lake Champlain may be more susceptible to damage from climate change than was previously understood — and that, therefore, the rules created by the Environmental Protection Agency to protect the lake may be inadequate to prevent algae blooms and water quality problems as the region gets hotter and wetter.

“This paper provides very clear evidence that the lake could be far more sensitive to climate change than is captured by the current approach of the EPA,” says UVM professor **Asim Zia, Ph.D.**, the lead author of the study. “We may need more interventions — and this may have national significance for how the agency creates regulations.”

The study, led by a team of ten scientists from UVM and one from Dartmouth College, used a powerful set of computer models that link the behavior of social and ecological systems. Their results show that accelerating climate change could easily outpace the EPA’s land-use management policies aimed at reducing the inflow of pollution from agricultural runoff, parking lots, deforestation, cow manure, lawn fertilizer, pet waste, streambank erosion — and other sources of excess phosphorus that cause toxic algae and lake health problems.

By connecting sub-models — of human behavior and land use, watershed dynamics, global climate models “downscaled” to the local region, and the hydrology of the lake itself — the overall model links together “the behavior of the watershed, lake, people and climate,” says **Judith Van Houten, Ph.D.**, UVM professor of biology, director of Vermont EPSCoR, and co-author on the study. This provides “a way forward to pull back the veil that often surrounds effects of climate change,” she says.

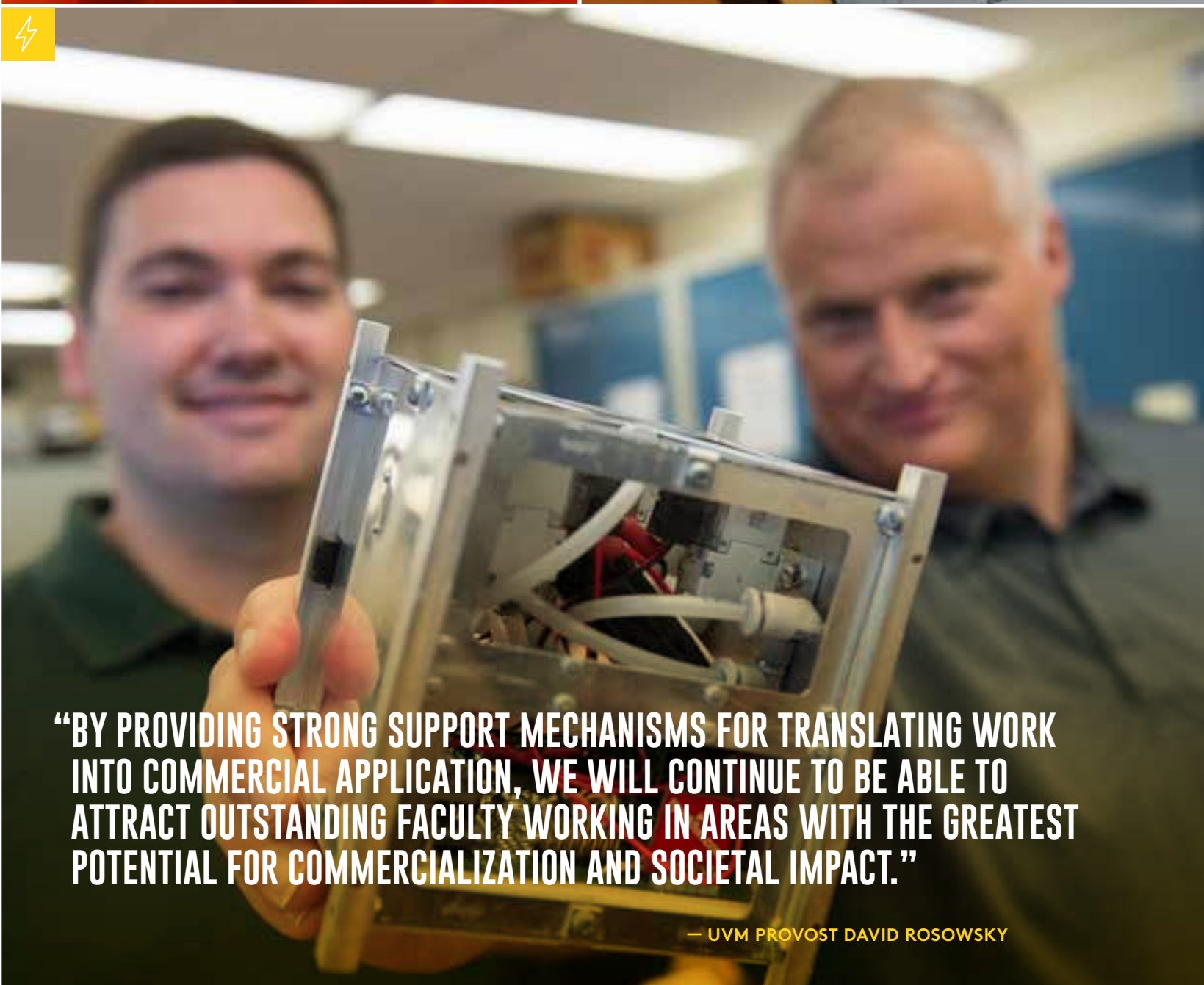
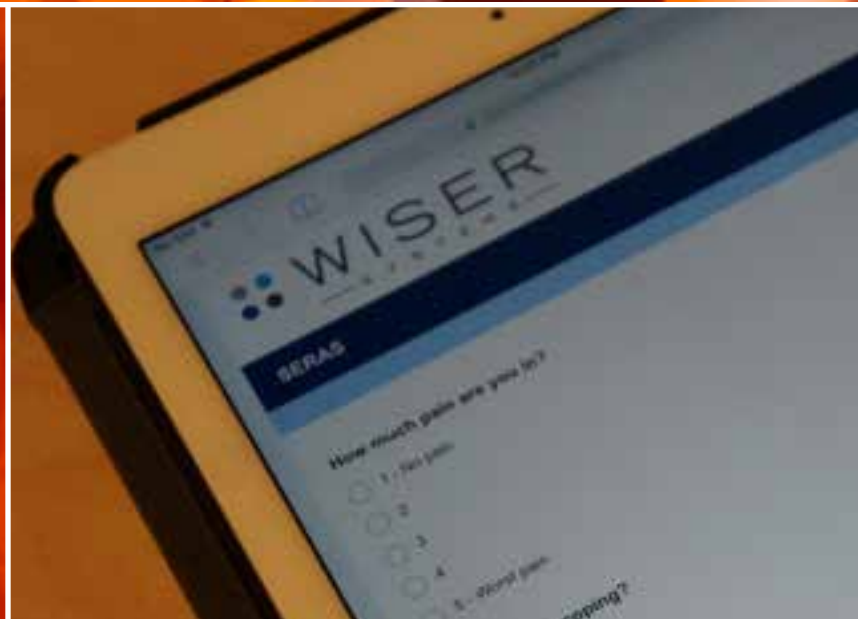
UVM hydrologist **Arne Bombliès, Ph.D.**, a co-author on the study, notes that, “We show through this modeling work the importance of a more comprehensive consideration of climate change impact mechanisms to achieve water quality goals, and the need to adequately address climate change uncertainty.”

“Lake Champlain’s future is sensitive to climate change,” Bombliès says. “And similar challenges are faced by other impaired waters throughout the United States.” **i**

Opposite: UVM geologist Paul Bierman, Ph.D., conducting research in Greenland. At left: UVM Professor Asim Zia, Ph.D.

BEHIND THE SCENES

As the UVM Theatre 2016–17 season began, faculty, students, and staff of the Department of Theatre prepared to hit the boards at the Royall Tyler Theatre with, *Stupid F*#king Bird*, a provocative play by the award-winning writer Aaron Posner that presented, as its title suggests, an edgy, irreverent take on a classic of modern theatre, Anton Chekov's play *The Seagull*. Ever-present and watching over the production from the wall at the back of the stage was the visage of Chekhov himself, painted by Professor and former Chair of Theatre **JEFFREY MODERER, M.F.A.**, the department's resident scenic designer. A scenic design expert with over 400 professional credits to his name, Modereger has worked on national tours of *Kiss Me, Kate* and *Singin' in the Rain*, the Showtime series *The Brotherhood* and on the Disney film *Underdog*. Modereger and his colleagues' work with students was recognized this year with a top 10 rating among B.A. programs in the nation by the popular theatre blog *OnStage*.



“BY PROVIDING STRONG SUPPORT MECHANISMS FOR TRANSLATING WORK INTO COMMERCIAL APPLICATION, WE WILL CONTINUE TO BE ABLE TO ATTRACT OUTSTANDING FACULTY WORKING IN AREAS WITH THE GREATEST POTENTIAL FOR COMMERCIALIZATION AND SOCIETAL IMPACT.”

— UVM PROVOST DAVID ROSOWSKY

Sparkling Success

NEW KNOWLEDGE IS APPLIED BEYOND THE CAMPUS WITH SPARK-VT.

BY ERIN POST

As a mechanical engineering doctoral student at the University of Vermont, **Ryan McDevitt, Ph.D. '14**, found himself at the front lines of a revolution in satellite technology — one focused on making these giants of space exploration much, much smaller. Around 2009, just as McDevitt began his graduate work, CubeSats — micro satellites measuring 10cm by 10cm — had started to come into their own as a viable alternative to the larger, more expensive satellites that had been the standard since the time of Sputnik. The problem: Their lighter weight also makes them more susceptible to perturbations in orbit. They also can't easily move out of the way of larger objects, and controlling how they “de-orbit,” or come back down to Earth, poses some challenge.

Enter UVM Professor of Mechanical Engineering **Darren Hitt, Ph.D.**, an expert in small spacecraft propulsion, who had received a \$750,000 NASA grant to continue his work on how to better maneuver micro satellites. McDevitt and Hitt teamed up as Ph.D. student and mentor, and their collaboration resulted in a viable concept for a new, cost-effective micropropulsion system.

When McDevitt finished his degree and left UVM in 2014, the project could have ended there, never making it past the prototype they fabricated on a 3-D printer, or out of the pages of McDevitt's doctoral thesis. But Hitt and McDevitt wanted to see it go further: They saw real potential in the system they developed to improve the function of these micro satellites.

But how to get it out of the lab and into the hands of companies who could use the technology?

Into the void stepped SPARK-VT, a program from UVM's Office of the Vice President for Research that brings a panel of distinguished and successful entrepreneurs together with UVM researchers to critically evaluate innovative applications of new knowledge. The program casts a wide net: Faculty from across UVM may apply for SPARK-VT funding. From the pool of proposals that come in, a handful of teams are selected to present. Each team brings to the panel a pitch for why their project deserves funding, be it a novel therapeutic, a new device, or an imaginative application of an existing technology.

Researchers are expected to go beyond the science. They also need a viable business plan, and a good answer for the need their project fills in the marketplace.

In 2016, Hitt and McDevitt successfully made it through that gantlet. They were one of four teams to garner a \$50,000 SPARK-VT grant, which came at a critical time for their fledgling project.

“SPARK-VT was a lifeline,” says McDevitt. “We needed to show investors and companies that this is more than work in a lab.”

McDevitt took the funds to the Vermont-based company he co-founded, now called Benchmark Space Systems (formerly GreenScale Technologies), to develop a prototype of the micropropulsion system that could be manufactured on a larger scale.

The work that resulted from the SPARK-VT grant helped launch McDevitt and Hitt onto a larger stage, and the accolades were quick to come in. In 2016, McDevitt's company was named one of the nation's top 36 university-spawned start-up companies by the National Council of Entrepreneurial Tech Transfer. McDevitt was also a finalist in the 2017 Launch VT competition, a program from the Lake Champlain Chamber of Commerce, cementing his place in the top echelon of entrepreneurs across the state.

“SPARK-VT WAS A LIFELINE... WE NEEDED TO SHOW INVESTORS AND COMPANIES THAT THIS IS MORE THAN WORK IN A LAB.”

— RYAN MCDEVITT, PH.D.

Opposite, top: the SERAS suicide risk assessment device. Opposite, bottom: Ryan McDevitt, Ph.D., and Professor Darren Hitt, Ph.D., with their prototype micropropulsion system.

Since its founding in 2013, SPARK-VT has helped to bridge that divide between academia and the marketplace for scores of UVM faculty. With roots in the Department of Medicine, the largest academic department at UVM’s Larner College of Medicine, SPARK-VT came in part as an answer to what is known as the “valley of death,” or that period of time between the genesis of an idea and its commercialization. Often, researchers run up against funding and regulatory hurdles that prove too difficult to surmount, stopping potentially useful or even groundbreaking inventions from becoming widely available. Department of Medicine Chair **Polly Parsons, M.D.**, saw in a similar program at Stanford University the potential to help her more than 180 faculty move their work forward. She tapped UVM Professor of Medicine **Mercedes Rincon, Ph.D.**, and **Eric Gagnon**, department business manager, with getting SPARK-VT off the ground. That first year, five researchers made presentations to the SPARK-VT panel, and two received funding.

Since then, the program has been on an upward trajectory. The following year, in 2014, SPARK-VT expanded to include researchers from across the College of Medicine, and in 2015, it began accepting proposals from across the University. The results have been impressive. Since its founding, SPARK-VT has received 55 applications and awarded 16 seed grants at roughly \$50,000 each. Two start-ups have been established by SPARK-VT research teams, and three are under consideration. UVM has also seen an uptick in the number of invention disclosures by faculty, which can be attributed not only to SPARK-VT grants but also to the program raising the “visibility of commercialization.”

“Each year, we see a growing number of faculty interested in commercialization of their work,” says UVM Provost **David Rosowsky**. “By providing strong support mechanisms for translating work into commercial application, we will continue to be able to attract outstanding faculty working in areas with the greatest potential for commercialization and societal impact.”

At the heart of this support system are the 21 SPARK-VT panelists, who hail from across the country and volunteer their time to the cause. Their expertise spans a wide range of fields, including patent law, biotech development, clinical trial leadership, engineering, and entrepreneurship.

“They’re very motivated,” says Rincon, who has played a key role in cultivating the group over the years. She says panelists appreciate the opportunity to “evolve the conversation” around entrepreneurship, and are eager to help faculty develop critical skills in an ever more competitive funding environment. Gagnon points out that this often means a focus on communication.

“Feedback from the SPARK-VT panel helps researchers move from a science talk to an actual pitch,” he says. “How do you convey your ideas to a group of people who aren’t scientists?”

The panel not only provides immediate response to faculty chosen to present their projects, they also give suggestions to all faculty who submit proposals. Often, teams refine their pitches and resubmit to SPARK-VT. Every funded team comes back to the panel one year out to report on progress, providing another opportunity for advice and guidance.

SPARK-VT METRICS

NUMBER OF SPARK-VT APPLICATIONS, GRANTS SINCE PROGRAM LAUNCH IN 2013

- 55 applications (average of 10–13 a year)
- 16 funded at approximately \$50,000 each

PATENTS FOR SPARK-VT FUNDED PROJECTS

- 36 patent applications in various stages
- 6 issued patents

NUMBER OF STARTUPS FOR SPARK-VT FUNDED PROJECTS

- 5

EXTERNAL RESEARCH FUNDING RECEIVED FOR SPARK-VT PROJECTS

- \$1.5 million

SBIR*/ STTR** FUNDING FOR SPARK-VT PROJECTS

- 18 SBIR/STTR grant applications submitted between 2014–2016
- 5 were funded, a 28% success rate (despite adverse federal funding environment)

EVIDENCE THAT SPARK IS CHANGING UVM CULTURE

- Average number of invention disclosures (all of UVM), 2011–2013: 37
- Average number of invention disclosures (all of UVM), 2014–2016: 47
- Total number of invention disclosures in 2016: 56
- Average number of SBIR/STTR grants submitted per year (all of UVM), 2011–2013: 14
- Average number of SBIR/STTR grants submitted per year (all of UVM), 2014–2016: 23

*Small Business Innovation Research grant **Small Business Technology Transfer

Isabelle Desjardins, M.D., associate professor of psychiatry and chief medical officer of the UVM Medical Center, has seen the benefits of this feedback with her own work on SERAS, or Systematic Expert Risk Assessment for Suicide, with a team comprising faculty from the Larner College of Medicine and Grossman School of Business, including **Sanchit Maruti, M.D.**, **Robert Althoff, M.D., Ph.D.**, and **William Cats-Baril, Ph.D.** The tool, which is self-administered by patients, asks a series of questions to determine near-term suicide risk, replicating the thinking of an experienced psychiatrist using a novel neural network-based algorithm. SERAS helps to address an important public health problem: Suicide is among the top four leading causes of death in individuals between the ages of 10 and 54, and it claims 25 percent more lives annually than motor vehicle accidents. A study published in the *Journal of Clinical Psychiatry* in June of 2016 showed promising results for SERAS: For levels of near term suicide risk, the model predicted psychiatrists’ assessment at between 91 and 94 percent.

After receiving a 2016 SPARK-VT grant, Desjardins’ team — through the company they formed called WISER Systems — was able to attract investors and conduct a pilot implementation of SERAS. Although their first attempt at winning a Small Business Innovation Research (SBIR) grant was unsuccessful — a common occurrence for this competitive federal program — feedback helped them to refine their application for a second try, which was funded in May 2016. This grant writing support now extends university-wide: SPARK-VT has been able to leverage its network of experts to offer a workshop series on topics ranging from intellectual property to market analysis to the art of the pitch. And a partnership with the Grossman School of Business, led by **Eric Munson, Ph.D.**, the Steven Grossman Endowed Chair in Entrepreneurship, links senior business undergrads with researchers to help them develop a business plan.

“SPARK-VT is connecting scientists and entrepreneurs,” says Desjardins. “It has created a space to have the kind of conversation that puts ideas into action.”

That conversation continues to expand. Thanks in part to the success of SPARK-VT, Rincon received funding to set up a Fostering Idea State Entrepreneurship (I-Trep) program. Open to faculty and post-doctoral fellows in Alaska, Maine, New Hampshire, Puerto Rico, Rhode Island and Vermont, the goal is to support investigators in states where the aggregate success rate for applications to the NIH has been historically low. I-Trep offers a webinar series, a biomedical entrepreneurship course, a consultant service, and travel awards to several national meetings.

All of this has helped to position UVM as a leader in Vermont’s emerging entrepreneurship ecosystem. One important marker of success? The partnerships SPARK-VT has helped to foster between UVM researchers and Vermont businesses, with Hitt and McDevitt as one prime example. Grant awards are another key benchmark. Out of 18 applications from SPARK-VT participants to the federal SBIR and STTR grant programs between 2014 and 2016, half were funded, a high rate of success.



Above: The SERAS team — Robert Althoff, M.D., Ph.D., Sanchit Maruti, M.D., Isabelle Desjardins, M.D., and William Cats-Baril, Ph.D. — examine their tablet-based suicide risk assessment tool.

And then there are the accomplishments of SPARK-VT grant recipients.

Hitt and McDevitt have a busy year ahead. After winning a second SPARK-VT grant in 2017 with a third collaborator, UVM Assistant Professor of Mechanical Engineering **Patrick Lee, Ph.D.**, the team is courting investors and hopes to launch a satellite to test their micropropulsion system by 2019.

Desjardins’ team is focused on recruiting a sales force and has several hospitals interested in SERAS. Receiving a 2016 Innovation Award from the Patient Safety Movement Foundation helped build momentum for this push. Her team is also working with UVM Complex Systems faculty on a project that uses publicly available social media data as another tool to predict near term suicide risk.

Both SPARK-VT grant recipients also recently took their place on the international stage. The companies formed by Desjardins and McDevitt were selected for the 2017 National Innovation Summit and Showcase, the world’s largest showcase of industry-vetted emerging technologies ready for commercialization. They joined five other invitees from UVM and UVM Medical Center, putting UVM in the top 10 percent of all universities, federal labs, government research centers and companies submitting applications for the event.

At the root of this success is a solid foundation built by an innovative UVM program.

“SPARK-VT is what helped push us from the idea of a company to a company,” says McDevitt. “It’s not just the money, but the mentorship and support structure they built that helped us get there.” **i**

THE COLLABORATIVE ART

YUTAKA KONO, D.M.A., knows the creative process as a performer on the tuba and as a composer. As a conductor, for both the UVM Symphony and the Burlington Chamber Orchestra, this assistant professor of music brings another dimension to his creative work — meeting the particular challenges that come with standing, baton in hand, dozens of musicians before him and hundreds of listeners behind him, bringing a composition to life at a moment in time. In rehearsal, the final sound emerges each time the musicians and conductor run through a piece. “It is always a two-way communication,” Kono says. “Sometimes students will bring an interesting way of playing a particular section or phrase. Say we have a melody played by the violins, clarinets, and flutes. If I like the way the violins are playing it, I’ll encourage the flutes and clarinets to listen to and imitate that way of playing. Ultimately, I see my job as trying to unify the sound of the orchestra.”

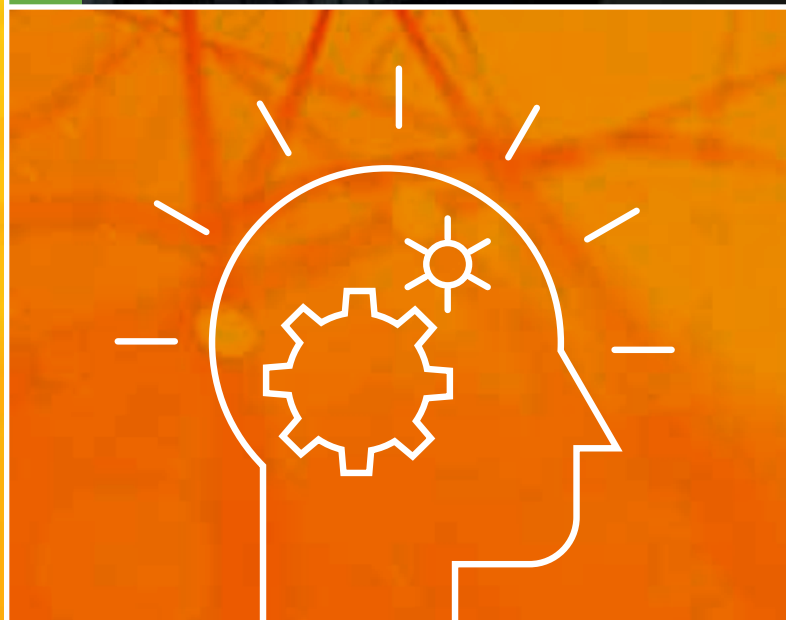


See Dr. Kono play and discuss the tuba
at [UVM.EDU/INQUIRY](https://uvm.edu/inquiry)



“THIS RESEARCH WILL GENERATE A VASTLY LARGE AND DETAILED DATASET THAT WILL YIELD INSIGHTS FOR DECADES TO COME INTO THE TRANSITION FROM CHILDHOOD TO ADOLESCENCE THROUGH TO ADULTHOOD.”

— HUGH GARAVAN, PH.D.



The Young Brain

UVM RESEARCHERS PROBE THE FORMATIVE YEARS OF THE HUMAN MIND.

BY JENNIFER NACHBUR
AND CAROLYN SHAPIRO

Adolescence is a time of extraordinary physical, emotional, and intellectual growth, as well as a time of changing social environments full of new challenges and opportunities that help shape a young person's adult identity, health and well-being. There is much to learn about how varied adolescent experiences — participation in extracurricular activities, playing video games, sleep habits, head injuries from sports, experimentation with alcohol, tobacco, marijuana or other substances — affect development. This is particularly true in a rapidly changing world dominated by social media and other forms of communication in which adolescents readily engage.

“We know the brain is still developing well into the mid-20s, making it vulnerable to a host of influences,” says National Institutes of Health Director Francis S. Collins, M.D., Ph.D.

Faculty members across UVM are paying close attention to the young brain in their research. **James Hudziak, M.D.**, professor of psychiatry and director of the Vermont Center for Children, Youth and Families, and his colleague **Matthew Albaugh, Ph.D.**, turned their attention in recent years to children 6 to 18 years old. They found that children who play the violin or study piano could be learning more than just Mozart: musical training might also help kids focus their attention, control their emotions and diminish their anxiety. Their research was published in the *Journal of the American Academy of Child & Adolescent Psychiatry*. The authors noted that their study was “the largest investigation of the association between playing a musical instrument and brain development.” They found that music playing altered the motor areas of the brain, because the activity requires control and coordination of movement. Even more important to Hudziak were changes in the behavior-regulating areas of the brain. For example, music practice influenced thickness in the part of the cortex that relates to “executive functioning, including working memory, attentional control, as well as organization and planning for the future.”

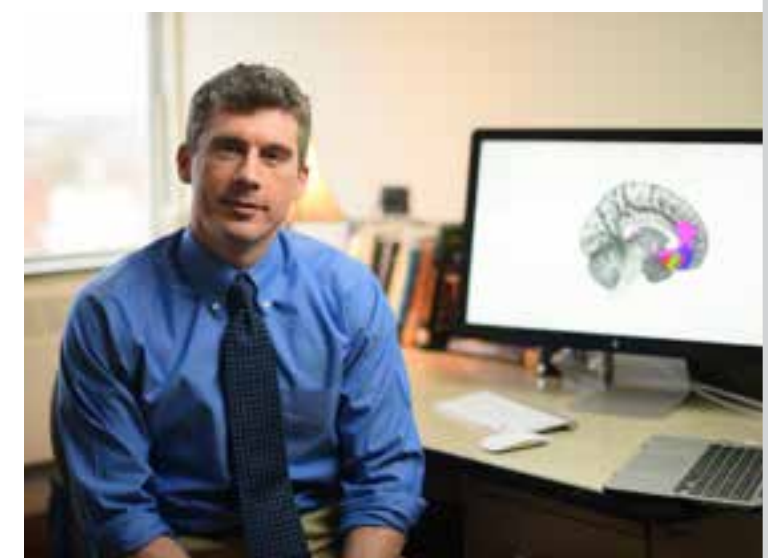
In a different study, Hudziak has looked into the potential dangers of ice hockey for young athletes. He and Albaugh and UVM colleagues **Catherine Orr, Ph.D.**, and **Richard Watts, Ph.D.**,

published a groundbreaking study in the *Journal of Pediatrics* that showed a relationship between concussions sustained by young ice hockey players and subtle changes in the cortex.

The UVM team used advanced imaging technology and cognitive testing to assess 29 Vermont ice hockey players between ages 14 and 23, some diagnosed with a sports-related concussion. As the severity of the athletes' concussion symptoms increased, the researchers found, the cortex got thinner in areas where it should be dense at those players' ages — areas that relate to attention control, memory, and emotion regulation.

“We believe that injury to a developing brain may be more severe than injury to an adult brain,” Hudziak says.

“The concern is that what we are finding may be an early marker of brain damage,” Albaugh says. “Years of playing contact sports and repeatedly getting your head knocked around



Opposite top: Associate Professor of Psychiatry Hugh Garavan, Ph.D., examines a brain scan at the UVM MRI Center for Biomedical Imaging. Above: Assistant Professor of Psychiatry Matthew Albaugh, Ph.D.



At top: Assistant Professor of Psychiatry and Psychological Science Alexandra Potter, Ph.D., and her colleague Matthew Albaugh, Ph.D. Above: Professor of Psychiatry James Hudziak, M.D., is also director of the Vermont Center for Children, Youth and Families.

probably isn't good for the brain, especially in young children whose brains are still maturing.”

Other UVM faculty play key roles in recruitment for the largest long-term study of brain development and child health in the United States — the Adolescent Brain Cognitive Development (ABCD) study — which launched in 2016. The landmark study by the National Institutes of Health (NIH) is following the biological and behavioral development of more than 10,000 children beginning at ages 9–10 through adolescence into early adulthood. Recruitment is occurring over a two-year period through partnerships with public and private schools near research sites across the country, as well as through registries of twins.

“With several NIH institutes and centers working together on this important study, we will be able to learn how a variety of biological events and environmental exposures affect brain development, giving us greater insight into what helps adolescents traverse that potentially tumultuous time to become healthy and productive adults,” said NIH director Francis Collins at the study’s outset.

The University of Vermont is one of 19 centers participating in the ABCD study. Psychiatry faculty members **Hugh Garavan, Ph.D.**,

and **Alexandra Potter, Ph.D.**, serve as the site principal investigators. Recruitment is coordinated through elementary schools throughout Vermont and continues for the next two years. Study information will be distributed to parents through their local schools.

“We are very gratified with Vermont’s inclusion, given this study’s aim to characterize psychological and brain development in as representative a sample as possible of U.S. youth,” says Garavan. “This research will generate a vastly large and detailed dataset that will yield insights for decades to come into the transition from childhood to adolescence through to adulthood.”

During the course of the next decade, the ABCD study scientists will use advanced brain imaging, interviews, and behavioral testing to determine how childhood experiences interact with each other and with a child’s changing biology to affect brain development and — ultimately — social, behavioral, academic, health and other outcomes.

Understanding these relationships may help reveal the biological and environmental building blocks that best contribute to successful and resilient young adults. This enhanced knowledge also may lead to ways to predict potential developmental problems so that they can be prevented or reversed. Families that volunteer will be part of groundbreaking research that promises to inform future educational strategies, child development innovations, research priorities, more effective public health interventions, and science-based policy decisions.

The ABCD Coordinating Center is housed at the University of California at San Diego and recruitment is conducted through schools at 19 study sites across the country.

Other UVM faculty participating on the ABCD study research team include Albaugh and Hudziak, **Julie Dumas, Ph.D.**, associate professor of psychiatry; and Richard Watts, Ph.D.

Another effort focuses on a common but little understood condition. Despite diagnoses for attention-deficit/hyperactivity disorder (ADHD) occurring in a reported 11 percent of U.S. school-aged kids, clinicians still do not fully understand the disorder’s underlying causes. Now a brain marker may be on the horizon, thanks to a new approach by UVM faculty that provides evidence of a relationship between brain structure and

dimensional measures of ADHD symptoms. The study’s results were reported in March in the journal *Biological Psychiatry*.

Using data from the European IMAGEN study, researchers, including Matthew Albaugh took a multi-informant approach to investigate whether or not dimensional measures of ADHD symptoms and brain imaging data could shed new light on the root source of ADHD’s symptoms, including inattention, hyperactivity and impulsivity. Their work represents the largest structural imaging study to date on ADHD symptoms in adolescents.

“Few studies have examined the relationship between ADHD symptomatology and brain structure in population-based samples,” say Albaugh and the study’s authors, who rather than taking what is called a “categorical” approach — a comparison of ADHD patients and controls — took a quantitative, dimensional, multi-informant approach. This method dovetails with work done by UVM’s **Thomas Achenbach, Ph.D.**, and colleagues, revealing aspects of dimensionality with regard to many psychiatric conditions, including ADHD.


“It’s not whether or not one has attention problems, it is the degree to which one is inattentive,” says Albaugh.

For the study, Albaugh and his colleagues, including Garavan, Potter, **Robert Althoff, M.D., Ph.D.**, and **Scott Mackey, Ph.D.**, examined psychopathology and imaging data from 1,538 adolescents. The data included parent ratings of ADHD symptoms collected through the Strengths and Difficulties Questionnaire (SDQ), and self-reports from the adolescents in the study through the youth version of the SDQ. The team also derived ADHD symptom counts from parent interviews — and then related ADHD symptom counts to brain structure.

When they overlaid the imaging results from all of their analyses — using behavioral questionnaire data and symptom counts — they found an anatomical region of convergence; ADHD symptoms reported by parents and adolescents were related to reduced gray matter volume in an area of the prefrontal cortex, the ventromedial prefrontal cortex (vmPFC). This relationship was particularly true for symptoms of inattention.

The team also found that this area of anatomical convergence was related to an objective behavioral measure of attention that has been previously associated with ADHD — reaction time variability. Past research by others has shown that ADHD youths exhibit more variability in their response times, and this is believed to reflect inattention and distractibility. Albaugh and colleagues found that greater variability in reaction time was associated with reduced volume in the vmPFC.

The connection of reduced vmPFC volume to inattention sets the stage for follow-up research, says Albaugh, who believes these findings could affect future ADHD interventions to strengthen this region of the brain. The work may also help to identify which youth go on to experience elevated symptom levels later in adulthood.

“We are finding that volume in this brain area predicts symptom change from adolescence to adulthood,” says Albaugh. “It’s exciting to think that, down the road, there might be real clinical utility to these results.” 

“FEW STUDIES HAVE EXAMINED THE RELATIONSHIP BETWEEN ADHD SYMPTOMATOLOGY AND BRAIN STRUCTURE IN POPULATION-BASED SAMPLES.”

— MATTHEW ALBAUGH, PH.D.



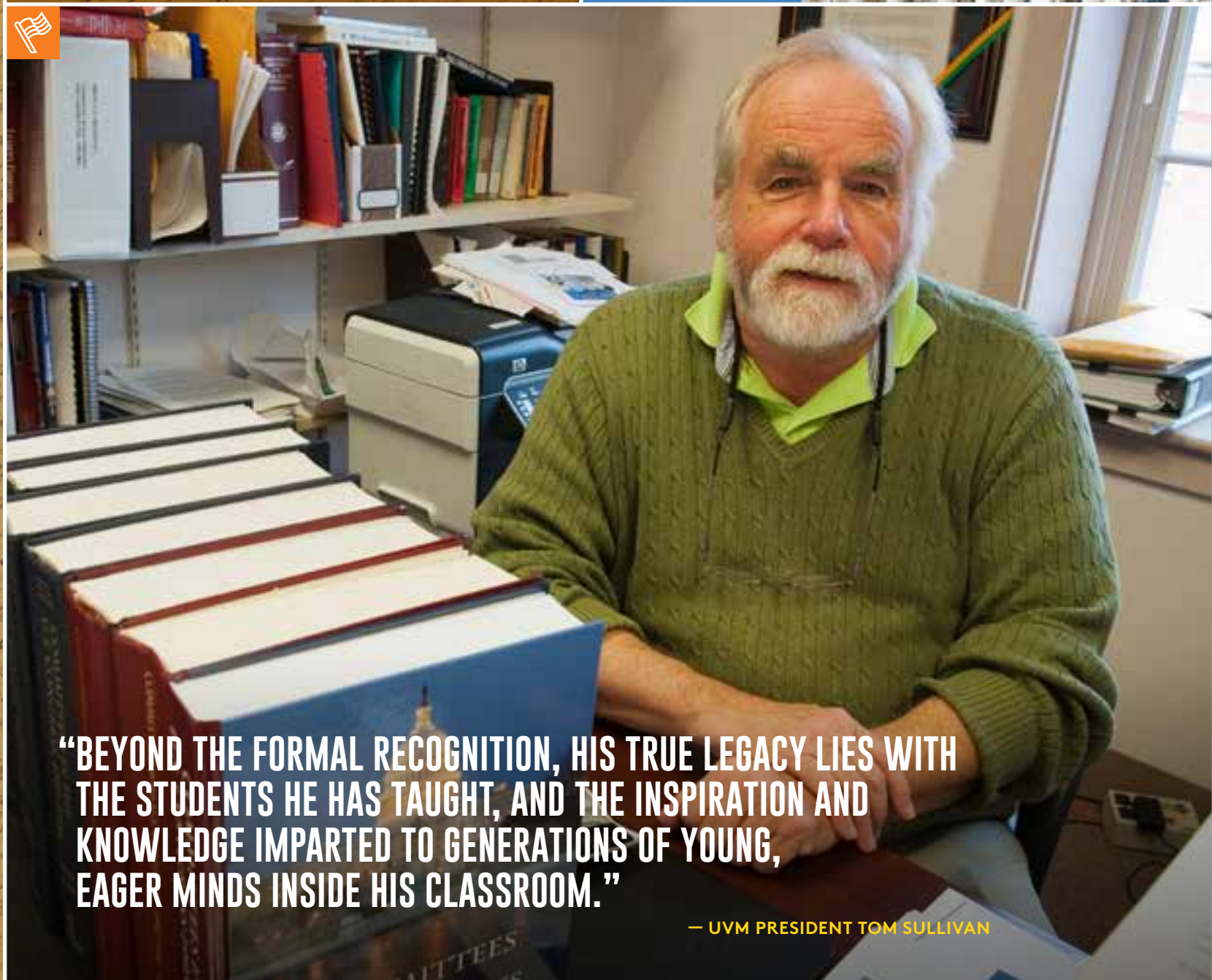
ENCOURAGING HEALTHY DECISIONS

LIZZY POPE, PH.D., assistant professor in the UVM Nutrition and Food Sciences Department, also directs the Didactic Program in Dietetics. Pope enjoys looking at the thought process behind the food and exercise choices people make, and then testing ways to impact these decisions with minimal willpower expenditure. “Throughout my academic journey I’ve always gravitated toward the psychology behind food and exercise decisions and why people make the choices they do,” she says. “My current research uses behavioral economic strategies such as providing incentives or shifting default options to mindlessly promote healthy options. The overarching goal of my research is to make the healthy choice the easy choice across circumstances, populations, and environments.” This year, along with her colleague Bernice Garnett, Sc.D., assistant professor of education in the College of Education and Social Services, Pope created a new mobile game aimed at encouraging teens to exercise with similar virtual rewards. Called “Camp Conquer,” the project is one of the first in the area of gamification and obesity, and was test-launched with the cooperation of 100 Burlington High School students in January.



See Dr. Pope explain her incentive research at [UVM.EDU/INQUIRY](https://uvm.edu/inquiry)





“BEYOND THE FORMAL RECOGNITION, HIS TRUE LEGACY LIES WITH THE STUDENTS HE HAS TAUGHT, AND THE INSPIRATION AND KNOWLEDGE IMPARTED TO GENERATIONS OF YOUNG, EAGER MINDS INSIDE HIS CLASSROOM.”

— UVM PRESIDENT TOM SULLIVAN

Congressional Study

FOR NEARLY FIVE DECADES, POLITICAL SCIENTIST AND AUTHOR GARRISON NELSON HAS FOUND LIFE WITHIN THE ARCHIVES.

BY JEFFREY WAKEFIELD
AND JON REIDEL

Staffers in the Congressional Research Office were skeptical, to put it mildly, when University of Vermont political science professor **Garrison Nelson, Ph.D.**, approached them in 1975 about producing the first comprehensive history of legislative committees in the U.S. Senate and House of Representatives. Such a volume would be impossible to produce, they said, with information buried in obscure resolutions deep in the archives.

Thirty-five years, tens of thousands of hours, and millions of scanned pages later, Nelson and co-author Charles Stewart of MIT proved the experts wrong with the publication in 2010, by Congressional Quarterly Press, of the seventh and final volume of a work — *Committees of the U.S. Congress* — that tracked every single member’s committee comings-and-goings from 1789 to 2010, and provided a wealth of additional committee information to boot.

While such a work might seem arcane at best to average citizens, it is of great use to insiders — by 2010, earlier volumes in the series were ragged and dog-eared from staffers’ use, according to the Senate’s chief historian, Richard A. Baker. The series appears on official congressional listings of standard reference works on the federal legislative branch.

Discerning the seemingly indiscernible has been a hallmark of Nelson’s long career at UVM, one that continued to be apparent this past year with the publication of his biography of one of the most important but least understood Speakers of the House of Representatives in the nation’s history.

This is the outgrowth of a career at UVM that began when Nelson joined the faculty in 1968, after earning his A.B. from Boston University and his M.A. and Ph.D. from the University of Iowa. He is one of UVM’s longest serving faculty members.

In 2015 Nelson was named the inaugural Elliott A. Brown Green and Gold Professor of Law, Politics and Political Behavior. Nelson received the Kroepsch-Maurice Teaching Excellence Award in 2009, and was named the Fall 2013 College of Arts and Sciences Dean’s Lecturer.

“Beyond the formal recognition, his true legacy lies with the students he has taught, and the inspiration and knowledge imparted to generations of young, eager minds inside his classroom,” said UVM President **Tom Sullivan** at the Green and Gold investiture ceremony. Sullivan also quoted from one of Nelson’s former students, Maggie Steakley ’08, who wrote: “Garrison Nelson taught me what true commitment to a project looks like.”

That sense of commitment is apparent in Nelson’s latest scholarly work.

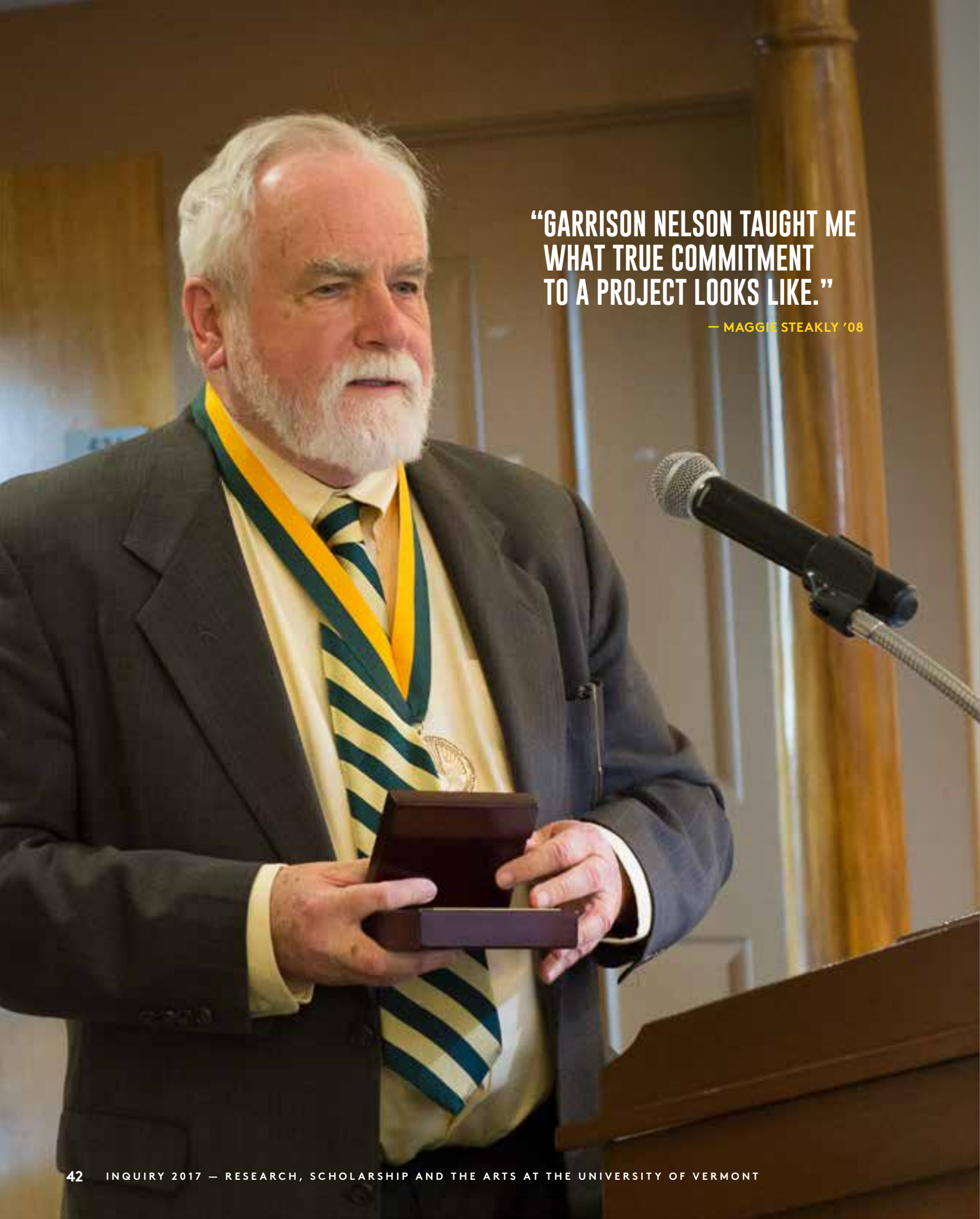
In early 20th century Boston, the path to political power required one of two backgrounds: Yankee Boston or Irish Boston. The former demanded a Pilgrim or Puritan ancestor and a degree from Harvard. The latter called for an Irish-born father, a widowed mother, and younger siblings that you helped raise in poverty.

John W. McCormack, the 44th U.S. Speaker of the House (1962–70) possessed neither of the Yankee requirements, and

“[MCCORMACK WAS] THE MOST SECRETIVE MAN I EVER MET... I COULDN’T UNDERSTAND WHY HE WAS THE ONLY SPEAKER WITHOUT A BIOGRAPHY UNTIL I STARTED DIGGING AROUND.”

— GARRISON NELSON, PH.D.

Opposite: Elliott A. Brown Green and Gold Professor of Law, Politics and Political Behavior Garrison Nelson, Ph.D., in his office in UVM’s Old Mill.



**“GARRISON NELSON TAUGHT ME
WHAT TRUE COMMITMENT
TO A PROJECT LOOKS LIKE.”**

— MAGGIE STEAKLY '08

had no Irish ancestry. He did, however, grow up in extreme poverty in South Boston — a.k.a. “Southie” — and used that as a basis to fabricate his personal history when he ran for the Massachusetts House in 1920.

The false narrative of the Irish kid from Southie propelled McCormack to a historic 43-year career in the U.S. House (1928–1971) and within a heartbeat of the presidency. Somehow, it remained intact until April of 2017, when Nelson published the first biography of McCormack.

Some 50 years in the making, *John William McCormack: A Political Biography* reveals stunning new facts about the background of a man considered the legislative architect of the New Deal and the Great Society. Nelson gives long overdue credit to a leading figure in the transformation of the 20th Century Democratic Party for passing a social welfare agenda that included Social Security, Medicare and Medicaid, immigration reform, and civil rights legislation.

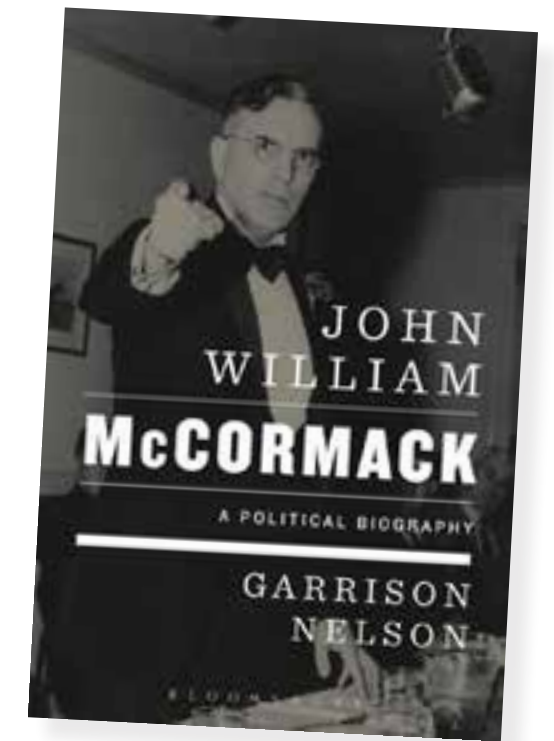
The most politically disqualifying discovery by Nelson was that McCormack’s father wasn’t Irish. He was a Canadian-born Scot who abandoned John and his younger — and older — siblings, and outlived his Boston-born wife. Nelson uncovered forgotten FBI files, falsified birth and death records, taped interviews with McCormack, and conducted his own interviews with family, friends and even cemetery caretakers as he chased clues from Ireland to Canada and across the U.S.

Previous attempts to write biographies of McCormack — the only post-1940 Speaker of the House without a biography until now — usually ended with the discovery of sanitized congressional papers located at Boston University, devoid of any pertinent personal information. Nelson was told early on by a political boss in Southie not to expect anyone to talk about their local hero and violate a code that says, “never write what you can speak; never speak what you can nod.”

“I kept waiting for someone to write the book, but no one ever did,” says Nelson, who spent over \$100,000 of his own money to complete the book about a man referred to by his longtime administrative assistant as “the most secretive man I ever met.” “I couldn’t understand why he was the only Speaker without a biography until I started digging around,” says Nelson.

Nelson caught a break when McCormack’s dying nephew gave him six boxes filled with family photographs, personal letters, news clippings, and gavels. “It was there that I found documents and letters that unlocked John McCormack’s hidden past and the successful reinvention of his family history that allowed him to ascend politically to the Speakership of the House and just one heartbeat away from the presidency between November 1963 and January 1965.”

Nelson traces his near-obsession with McCormack to an unexpected meeting with the Speaker in 1968 after stopping by his office to see if he’d answer some questions for his doctoral dissertation. “It was a wonderful hour for this 26-year-old new college instructor to enjoy a cigar with the 76-year-old House Speaker in the U.S. Capitol,” recalls Nelson, who had just been hired by UVM earlier that year. “This remarkable experience was



Above: The cover of Garrison Nelson’s latest work, the only biography of Speaker of the U.S. House of Representatives John McCormack. Opposite: Nelson at his 2015 investiture as Elliott A. Brown Green and Gold Professor of Law, Politics and Political Behavior.

the inspiration for this particular book as well as for most of my published research on the U.S. Congress.”

Nelson chooses not to harp on McCormack’s falsified past in his 910-page book, which David Shribman of the *Boston Globe* described in his review this spring as “a brilliant portrait not only of ‘Boston’s Forgotten Man,’ but also of the place that spawned him and of the era he occupied.” Instead, Nelson gives McCormack long-overdue credit for forging key political alliances, allowing his party to pass legislation to help the nation’s most vulnerable.

Known as “Boston Brahmin’s favorite Irishman, the South’s favorite northerner, and the Jews’ favorite Catholic,” McCormack maintained relationships with Southern Democrats, mainly Sam Rayburn of Texas, for 21 years during a period between 1940 and 1989 when the Speaker and Majority Leader positions were held by Democrats from Massachusetts and Texas. This so-called Austin-Boston Connection — the subject of a previous book by Nelson — reshaped the Democratic Party from a regional southern white Protestant party to one that embraced urban religiously and racially diverse ethnic groups, according to Nelson.

“Their impact on House politics and the national agenda was profound,” says Nelson. “The moderate and liberal Democrats now had their own alliance to counter the Conservative Coalition.”

Ultimately, Nelson doesn’t claim to know why McCormack fabricated his past, but strongly suggests it was because he wanted to lift himself, and people back in Southie and across the country, out of poverty. “McCormack understood as clearly as the Irish political gatekeepers how politics could be used to advance oneself and to alleviate the economic hardship of their Irish-descended constituents.” **i**

TRANSFORMING SPECIAL EDUCATION

In addition to her appointments as professor and vice chair in the UVM Department of Education, **KATHARINE SHEPHERD, ED.D.**, is the project director and co-principal investigator of a five-year, U.S. Department of Education-funded study supporting future leaders in special education, and a three-year grant from the Spencer Foundation that deals with improving instructional intervention for struggling students. She's also an author and editor — her latest book is titled *The Art of Collaboration: Lessons from Families of Children with Disabilities*; and recently she served as the guest co-editor of a special issue of the journal *Teacher Education and Special Education*. Shepherd is a past president of the Higher Education Consortium of Special Education, which presented her with its leadership and service award in 2016 to recognize her many contributions to the organization. In February, she was invested by UVM President Sullivan as the inaugural Levitt Family Green and Gold Professor.





“OUR TEAM IS INCREASINGLY WORKING WITH SCIENTISTS ACROSS THE UVM CAMPUS SO THAT IT CAN LEVERAGE THE CREATIVE THINKING AND THE BEST NEW TECHNOLOGIES OF THE 21ST CENTURY INTO AVENUES TO CONTROL THE BURDEN OF PERNICIOUS PROBLEMS WITH GLOBAL INFECTIOUS DISEASES.”

— BETH KIRKPATRICK, M.D.



Our Best Shot

UVM'S VACCINE TESTING CENTER RESEARCHERS COMBAT DISEASE WORLDWIDE.

BY EDWARD NEUERT
AND MARIAN MILLER

Researchers at the University of Vermont Vaccine Testing Center (VTC) study human vaccines and human immunology with the goal of understanding and preventing infectious diseases around the globe. The VTC team is particularly interested in developing and improving vaccines, and understanding how they best work to establish an immune barrier to infection. “Our work focuses on developing and understanding vaccines to prevent infectious diseases that have a major impact on health in low-income countries,” says Professor of Medicine **Beth Kirkpatrick, M.D.**, who founded and has directed the VTC for 15 years, “although in 2017, many of these same diseases now threaten all corners of the globe.”

The VTC predominately focuses on two areas in vaccinology. One area is flavivirus vaccines, which include mosquito-borne infections such as Dengue, Zika and West Nile viruses. The other is enteric infections, including bacteria, viruses and parasites infecting the intestinal tract. The VTC has studied several major enteric pathogens, including rotavirus, *Cryptosporidium*, *Campylobacter*, cholera, and typhoid.

For its U.S.-based studies, the center depends upon another important group — healthy volunteers — to accomplish its research mission. “Adult volunteers are critical to the evaluation of any new candidate vaccine,” says **Kristen Pierce, M.D.**, associate professor of medicine and lead clinical investigator on the VTC's Dengue vaccine program. “With this in mind, all of our human research studies are designed and performed with rigorous oversight and attention to safety.”

The VTC performs research at UVM and internationally. Their work depends on a diverse team of physician- and basic-scientists, international teams of collaborators, study coordinators, laboratory personnel, and data analysts focusing on vaccine development and human immunology from the vantage

point of the laboratory, field, or clinic. All share a common dedication to team-based science and an appreciation for the diverse skills that the team as a whole brings to the table.

In May 2017, the VTC hosted fifteen of the world's leading Rotavirus researchers at their *Symposium on Rotavirus Human Immunology: Advancing Science, Decreasing Disease*. Visiting scientists joined investigators from the VTC, including **Benjamin Lee, M.D.**, assistant professor of pediatrics and **Sean Diehl, Ph.D.**, assistant professor of medicine, to tackle major outstanding scientific issues critical to controlling the disease burden from Rotavirus diarrhea.

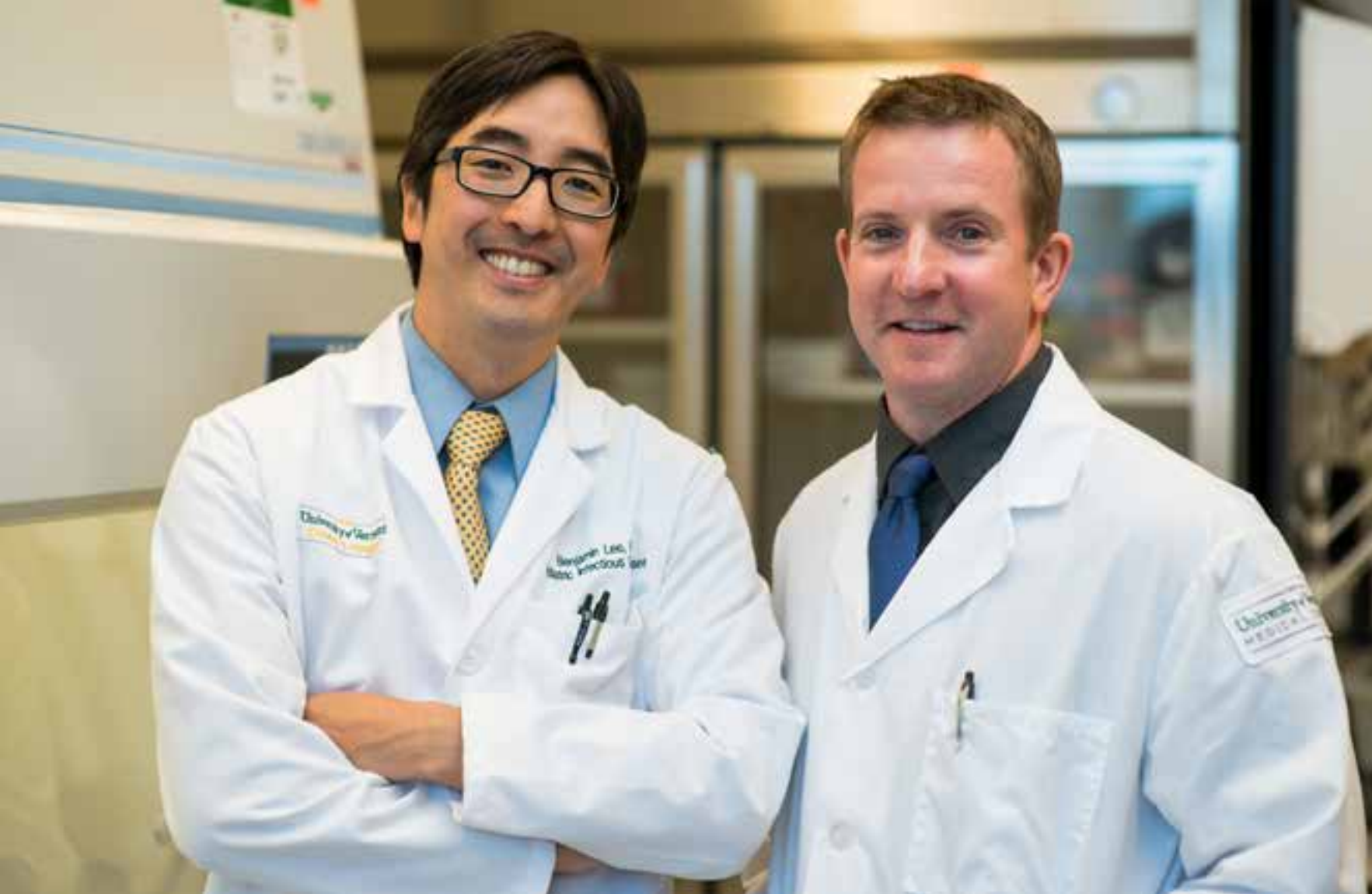
Before the advent of rotavirus vaccination a decade ago, almost 600,000 child deaths occurred globally each year due to rotavirus. Despite the success of oral vaccines, rotavirus infections remain the leading global cause of diarrhea-related child deaths. The vaccines, which are 95 percent efficacious in high-income countries, are only about 50 percent effective in low-income countries. This is why VTC researchers and their colleagues are seeking an improved immune marker which correlates with vaccine-induced protection that will help identify at-risk children.

Participants at the May symposium shared their research and experiences toward understanding and improving vaccine performance and the development of new immunology assays at UVM, which may be used as a new correlate of protection or risk. Scientists representing The Bill & Melinda Gates Foundation, the non-governmental organization PATH, and the U.S. Centers for Disease Control and Prevention were also in attendance. In addition, eleven U.S. and international academic institutions were represented, including ones from Columbia, India, and Bangladesh.

In July 2017, the VTC hosted another team of international scientists at UVM to discuss the human immunology of Dengue and Dengue Vaccines. Scientists from Johns Hopkins University, The National Institutes of Health (NIH), The University of North Carolina, The Bill & Melinda Gates Foundation, and La Jolla



Opposite, top: Professor of Medicine and UVM Vaccine Testing Center Director Beth Kirkpatrick, M.D., center, with Associate Professor Kristen Pierce, M.D. (left) and Associate Professor of Medicine Caroline Lyon, M.D.



Institute of Allergy and Immunology met with VTC scientists including Diehl, Kirkpatrick, and Pierce, as well as **Jon Boyson, Ph.D.**, professor of surgery and **Jason Botten, Ph.D.**, assistant professor of medicine, for in-depth updates on their research progress toward identifying the immune components needed to safely protect the human host from dengue infections and “epitope mapping” of the virus itself to understand how it interfaces with those immune components.

This immunology intensive work, the “IDEA” program, is funded by the Bill & Melinda Gates Foundation. Sean Diehl, a lead investigator and expert in human immunology notes, “this IDEA program was built upon the original clinical Dengue Vaccine program at the VTC, which has been ongoing here since 2009.” This umbrella program, funded by the NIH and Johns Hopkins, has permitted the continuous study of dozens of clinical trials of NIH-designed Dengue Vaccines at UVM, and a rich repository of specimens with which vaccine immunology can be better understood. The Dengue Vaccine clinical studies at UVM, which are large and complex operations involving a large



Above: UVM VTC researchers and Assistant Professors Benjamin Lee, M.D., and Sean Diehl, Ph.D. At right: a rack of blood samples are pulled from a liquid-nitrogen-cooled tank.

number of clinical trials staff and volunteers, have permitted the expansion of the vaccine trials infrastructure at UVM, which includes deep expertise in clinical trials, regulatory standards, and robust validated assays in the core laboratories. In the process, the combined VTC-JHU-NIH team has identified an effective, live, single-dose tetravalent Dengue vaccine. This vaccine has now been tested by the VTC team for safety in all ages in Dengue-endemic Bangladesh. The vaccine’s final major test for efficacy, which involves tens of thousands of persons in Brazil, is underway.

In efforts related to Dengue, as well as vaccines for enteric pathogens, the VTC has collaborated with the International Center for Diarrheal Disease and Research (*icddr,b*) in Dhaka, Bangladesh, since 2002. This partnership with pre-eminent *icddr,b* scientists such as **Firdausi Qadri, Ph.D.**, and **Rashidul Haque M.D., Ph.D.**, has yielded valuable information and deep relationships between the two centers.

One pathogen of interest to both is a bacterium that has serious impacts in the developing world, but is rarely seen in the U.S. — cholera. Cholera is caused by the bacteria *Vibrio cholera* and occurs in areas with poor sanitation, limited access to safe drinking water, and inadequate health care. According to the World Health Organization (WHO), globally there are an estimated three to five million cases of cholera infection and as many as 120,000 deaths due to the disease annually.

But there is hope for addressing this infectious disease. In June of 2016, the FDA approved the only vaccine to protect against cholera infection. The vaccine — *Vaxchora* — is currently available only in the U.S., but is undergoing modifications for global use. VTC researcher **Caroline Lyon, M.D., M.P.H.**, associate professor of medicine notes, “Outbreaks occurring in Yemen and the Democratic Republic of Congo demonstrate the importance of a single-dose oral cholera vaccine. We are proud that our work has led to approval of a vaccine that will impact so many people worldwide.”

The VTC was one of only three sites that conducted human trials to test the effectiveness of this groundbreaking vaccine. UVM’s involvement is not an accident. “UVM’s Vaccine Testing Center is one of only four or five sites in the U.S. capable of doing this type of vaccine human challenge study,” says Kirkpatrick.

Despite its name, the Vaccine Testing Center team has begun to expand outside the vaccine arena on other components of global infectious diseases. These areas include new avenues involving evaluation of new therapeutics, predictive modeling, and epidemiology. For example, there are no vaccines to treat or prevent *Cryptosporidium*, a leading cause of severe diarrhea in infants and young children in the developing world. This single-celled intestinal parasite is found in contaminated water and causes significant illness and death in immunocompromised individuals.

VTC interest in *Cryptosporidium* has led to collaborations with the laboratory of a highly innovative UVM physician-scientist in infectious diseases, **Christopher Huston, M.D.**,

“OUTBREAKS OCCURRING IN YEMEN AND THE DEMOCRATIC REPUBLIC OF CONGO DEMONSTRATE THE IMPORTANCE OF A SINGLE-DOSE ORAL CHOLERA VACCINE. WE ARE PROUD THAT OUR WORK HAS LED TO APPROVAL OF A VACCINE THAT WILL IMPACT SO MANY PEOPLE WORLDWIDE.”

— CAROLINE LYON, M.D., M.P.H.

associate professor of medicine, who has designed novel high-throughput techniques for testing libraries of chemical compounds which may serve as new therapies against *Cryptosporidium*. “Dr. Huston’s novel drug-testing methods have been a major advance in the development of new drugs against *Cryptosporidium*,” says Kirkpatrick. “These methods are being used world-wide by investigators and industries to evaluate novel therapeutic agents. This UVM award brings us closer to testing the effectiveness of these drugs in human populations.”

In collaboration with the University of Maryland’s Center for Vaccine Development, Huston, Lyon, and Kirkpatrick are designing a research platform upon which new Crypto treatments can be tested in humans. The work is being funded by a \$3.3 million grant to UVM from the Gates Foundation. “Diarrheal illness caused by *Cryptosporidium*, and the long-term consequences of this illness, has been underappreciated in children in the developing world,” notes Huston. “Fortunately, recent international studies have brought this problem to the attention of the public health community.” Caroline Lyon, who leads the clinical arm of this research, adds, “The opportunity to combine Dr. Huston’s laboratory innovation and the VTC’s clinical expertise to address this globally important need is truly exciting for us and the University.”

Kirkpatrick foresees that a name change may be needed to reflect the expanding focus of the VTC. “Over the past fifteen years, our interest in vaccines, the prevention of global infectious diseases, and the development of human immunity has allowed the team to expand into exciting and important new areas. Our team is increasingly working with scientists across the UVM campus so that it can leverage the creative thinking and the best new technologies of the 21st century into avenues to control the burden of pernicious problems with global infectious diseases.” **I**

NEW SOLUTIONS

The University Scholars program recognizes distinguished UVM faculty members for sustained excellence in research, creative, and scholarly activities. The Scholars are selected by a faculty panel based upon nominations submitted by UVM colleagues. Along with professors Jane Kolodinsky, Ph.D., and Kelly Rohan, Ph.D., 2017 saw **JIANKE YANG, PH.D.**, named as a scholar. Yang is a professor of applied mathematics in the Department of Mathematics and Statistics, where he joined the faculty in 1994. He has been editor-in-chief of the premier applied mathematics journal, *Studies in Applied Mathematics*, since 2014, the same year he received the inaugural College of Engineering and Mathematical Sciences Faculty Award for Excellence in Research. He also sits on the organizing board for two premier conferences, CLEO in the field of nonlinear optics, and IMACS in the field of nonlinear waves in general. His research in applied and physical mathematics has been supported by continuous extramural funding for the past 20 years. In 2016 he added to his 130 published peer-review articles with a study in *Reviews of Modern Physics*.



IMPACT

“THIS STUDY SHOWS QUANTITATIVELY, AND AUTHORITATIVELY, JUST HOW LARGE THAT CONTRIBUTION IS. WE’RE VERY PROUD OF THE ROLE UVM PLAYS IN THE STATE’S ECONOMY AND HAVE EVERY CONFIDENCE OUR IMPACT WILL ONLY GROW IN THE FUTURE.”

— TOM SULLIVAN,
PRESIDENT,
UNIVERSITY OF VERMONT

UVM’s Economic Benefit to Vermont: Over \$1.3 Billion

According to a study published in October 2016, the University of Vermont created \$1.33 billion in economic value for the state of Vermont in fiscal year 2014–15, the latest period for which complete data existed at the time. The University also supported 11,287 jobs throughout the state and generated \$78.8 million in state and local taxes during that period.

“The University of Vermont is a powerhouse for economic and community activity across the State of Vermont,” concluded the study, which was conducted by Tripp Umbach, a Pittsburgh-based research firm that specializes in economic impact analysis.

UVM created economic value, the study reports, in three ways: through its spending in the state, through the employment opportunities it offers, and through state and local tax revenue generated from spending, research activities and the visitors the University attracts to the region.

“We have long known that The University of Vermont is a powerful driver of the Vermont economy,” said UVM President Tom Sullivan. “This study shows quantitatively, and authoritatively, just how large that contribution is. We’re very proud of the role UVM plays in the state’s economy and have every confidence our impact will only grow in the future.”

UVM SPENDING IMPACTS

UVM’s spending in Vermont takes three forms: direct, indirect and induced. Direct expenditures are for goods and services purchased by the University, its faculty, staff, students and visitors.

Indirect and induced spending are “multiplier effects” when businesses in the state that receive direct payments from the University and the employees who received salaries from these companies re-spend the money within the state, creating the need for even more jobs.

UVM’s direct expenditures totaled \$556.1 million. Indirect spending was \$770.6 million, bringing the total to \$1.33 billion in economic activity.

UVM EMPLOYMENT IMPACTS

UVM also employs 4,400 faculty, staff and students. Their spending not only has a direct impact on the Vermont economy, it supports many other additional jobs in the state and region. These include jobs created by supply and equipment vendors, contractors, and laborers for the construction and renovation of University facilities, and jobs created in the community at hotels, restaurants and retail stores in support of the University’s workforce and its visitors.

Combining UVM’s direct employees with jobs created by University spending results in the 11,287 figure cited in the report.

UVM TAX IMPACTS

It’s a common misperception that public universities don’t generate tax revenue.

Through UVM’s local spending, as well as its direct and indirect support of jobs, the University generates a significant amount of tax revenues that contribute to the local and state tax base.

Its employees, students and the visitors the University attracts to the state also spend locally and create tax revenue, bringing the total to \$78.8 million in state and local taxes.

FIRST STUDY TO SHOW ECONOMIC IMPACT OF UVM RESEARCH

The study looked at a variety of subsets of the University’s contribution to the state economy. A critical one is the effect UVM’s large research enterprise — UVM is the state’s only research university — has on economic activity in the state. The Tripp Umbach study is the first to gauge the economic impact of UVM research.

In the year covered by the study, UVM reported \$128 million in research and educational grants and contracts, 84 percent of which came from out of state. As a result of its research activities, \$157.9 million was generated in the state. UVM’s innovative research efforts also supported 809 jobs in Vermont and added \$5.3 million in state and local taxes.

UVM research also affects the Vermont economy via new product development and technology commercialization, according to the study.

The study also broke out the impact of UVM’s Larner College of Medicine and the College of Nursing and Health Sciences. The economic contributions of both were calculated separately from those contributed by the University of Vermont Medical Center.

The Larner College of Medicine generated \$403.3 million in economic activity, supported 2,616 jobs and generated \$18.8 million in state and local taxes. The College of Nursing and Health Sciences had an economic impact of \$38.2 million, supported 419 jobs and produced \$28 million in state and local tax revenue.

COMMUNITY WORK ADDS \$15 MILLION

The report also calculated the impact of University employees and students who are active in the Vermont community through community service, local fund raising and cultural events. Calculating the value of the hours contributed and of donations made, the report concluded that University faculty, staff and students provided a community impact of \$15 million in fiscal year 2014.

The presence of the University is felt through donations made to community organizations such as the United Way or YMCA, as well as time donated for volunteer activities such as Habitat for Humanity or tutoring services for adolescents.

Finally, the study gauged UVM’s economic impact via the larger earning power its undergraduate and graduate students have once they earn their degrees. Comparing the earning power of the 2,319 UVM undergraduates who earned degrees in 2014, 60 percent of whom stay in state, with their earning power if they had only a high school degree, the report concludes that the additional wage premium amounted to \$30.8 million. A similar calculation with the 586 UVM students who earned advanced degrees in 2014 found that the additional dollars in salary came to \$5.9 million.

“We are confident that the report presents a highly accurate picture of UVM’s impact on the state’s economy,” said Richard Cate, the University’s vice president for finance.

The cost for the Tripp Umbach study was \$25,000, which was privately funded.



ECONOMIC IMPACT
IN VERMONT

\$1.33B

IN ECONOMIC VALUE FOR
THE STATE OF VERMONT

11,287

JOBS SUPPORTED THROUGHOUT
THE STATE BY UVM

2,616

JOBS SUPPORTED BY THE LARNER
COLLEGE OF MEDICINE

\$18.8M

STATE AND LOCAL TAX REVENUE
GENERATED BY THE LARNER
COLLEGE OF MEDICINE

\$38.2M

ECONOMIC IMPACT BY THE COLLEGE
OF NURSING AND HEALTH SCIENCES

\$78.8M

STATE AND LOCAL TAX REVENUE
GENERATED BY UVM

809

JOBS SUPPORTED BY RESEARCH
EFFORTS IN VERMONT

\$403.3M

ECONOMIC ACTIVITY GENERATED BY
THE LARNER COLLEGE OF MEDICINE

419

JOBS SUPPORTED BY THE COLLEGE OF
NURSING AND HEALTH SCIENCES

\$28M

STATE AND LOCAL TAX REVENUE
GENERATED BY THE COLLEGE OF
NURSING AND HEALTH SCIENCES

\$15M

COMMUNITY IMPACT BY FACULTY,
STAFF, AND STUDENTS AT UVM

Research Partnership Yields More Efficient Maple Syrup Process

It's a ratio every Vermont child learns at sometime early in elementary school: to make a gallon of maple syrup, 40 gallons of maple sap need to be boiled down. Now, maple company Lapierre Equipment and the University of Vermont Proctor Maple Research Center have announced a research collaboration to investigate new methods of maple sap processing that could dramatically change that ratio and significantly increase productivity.

The research partnership focuses on developing and testing a newly developed piece of equipment by Lapierre called a HYPERBRIX RO and evaporator. The device concentrates sap so it is 35 percent sugar before it is boiled in the evaporator. With the new Lapierre system, only 2.2 gallons of concentrate are needed, producing large energy and time savings compared to boiling raw sap. The new technology represents

a leap forward. Most RO (reverse osmosis) systems currently in use in the maple industry can concentrate sap from about 2 percent to 8 to 15 percent sugar.

"It was a natural progression for ROs to go to higher sugar concentration," said Carl Lapierre, director of R&D at the company. "We chose to stop at 35 percent, which is close to 95 percent of the water removed from the sap. The reason for this is simple — some amount of boiling is necessary to develop good flavor. We have completely redesigned the evaporator to optimize performance while maintaining excellent caramelization."



As part of the collaboration, Lapierre Equipment has supplied the Proctor Maple Research Center with the state-of-the-art HYPERBRIX RO and evaporator and additional syrup processing accessories for use in research and in UVM's 5,000 tap maple sugaring operation.

"This collaboration will put UVM solidly in the forefront of the technology of maple sap processing," said **Timothy Perkins, Ph.D.**, research professor and director of the Proctor Maple Research Center. "We look forward to several years of research on this new system to help push the curve ahead a little more."

The University of Vermont Proctor Maple Research Center is located in Underhill Center, Vt. Since it was established in 1946, the center is renowned for its work on the science and application of technology in the maple industry.

Funding Student Startups

In a city and state known for its innovative spirit, it's no surprise that student entrepreneurs at UVM are trying to get in on the action. To help these students bring their ideas to market, UVM students have developed a new innovation fund, which offers funding and expertise.

There's definitely no shortage of student entrepreneurs — from first-year **Casey Husband**, whose company, Lazarus Defense, creates products that help law enforcement during active shooter events, to business majors **Peter Silverman** and **Max Robbins**, whose startup, BeaconVT, is connecting local businesses with an untapped student workforce, to a plethora of early stage ideas.

In fall 2017, the Catamount Innovation Fund opens its "doors" to UVM undergraduate and graduate students seeking to collaborate with and invest in current student entrepreneurs and inventors, as well as recent alumni. With approval from UVM President **Tom Sullivan** and Vice President for

Research **Richard Galbraith, M.D., Ph.D.**, and through collaboration of numerous students, including medical student **Al Marchese '19** and economics graduate **Andrew Dazzo '17**, an undergraduate in economics, the group has raised capital for the fund to form an innovation team for the 2017–18 academic year.

The group anticipates proposals from a broad range of disciplines, including the engineering department's SEED program, healthcare-themed startups from medical students with guidance from Marchese, and environmental innovations from students in the Rubenstein School of Environment and Natural Resources.



Vermonters Benefit from UVM-Created Statewide Fiber Optic Network

On a Saturday afternoon in January, Vermont young-adult author Sarah Stuart Taylor found herself immersed in an animated discussion about writing. After sharing writerly wisdom at the Young Writers Project writing workshop she led at the Kellogg Hubbard Library in Montpelier, Taylor had asked the 20 teens in attendance to write a short piece of "micro-fiction." Fifteen minutes later, the bravest souls in the group read their creations aloud, launching a spirited back and forth.

The meeting was typical of the writing workshops the Young Writers Project periodically holds in Vermont in every way but one: Taylor and the teens were located at libraries in five different Vermont towns connected by state-of-the-art videoconferencing software and a blazingly fast broadband network.

"It's really hard to mimic the feeling of an in-person writing workshop" online, says Doug DeMaio, support and instruction coordinator for the Young Writers Project. "But having that instantaneous connection, and even setting up your chairs and tables in a way that it looks and feels like you're all sitting around one table, it's really powerful," a night-and-day improvement over the sessions YWP tried to run using conventional internet service. The new setup, says DeMaio, brings an experience to rural teens, like those who participated from the Rockingham Free Public Library, that is usually reserved for their counterparts in Vermont's bigger cities.

The virtual writing workshop was just the kind of outcome a team of University of Vermont faculty and staff envisioned seven years ago when they took steps, first, to connect UVM to a broadband superhighway called Internet2, a national initiative providing warp speed and massive bandwidth to research universities and government agencies and, second, to link institutions around the state, like the Vermont State Libraries, to the high performance information artery.

In 2009 IT and research higher ups at the flagship universities in Vermont, New Hampshire, Maine, Rhode Island and Delaware decided that the time had come to give their faculty a major internet upgrade, enabling them to easily exchange massive data sets with their colleagues at other institutions — a hallmark of the age of big data — by connecting to Internet2, which was attracting more universities every year. The group banded together as the Northeast Cyberinfrastructure Consortium and secured funding from the National Science Foundation and the National Institutes of Health to link to the Internet2 network.



Key members of the UVM team that helped create a statewide fiber optic network: (from left): Michael Voity, network engineer in UVM's Telecommunications and Network Services office; Patrick Clemins, cyber specialist at Vermont EPSCoR, a consortium of Vermont colleges led by UVM; and Randy Spooner, director of Telecommunications and Network Services. The lowest cable on the pole behind them, located in South Burlington, connects to an Internet2 node in Albany.

"IT'S REALLY HARD TO MIMIC THE FEELING OF AN IN-PERSON WRITING WORKSHOP ONLINE... BUT HAVING THAT INSTANTANEOUS CONNECTION, AND EVEN SETTING UP YOUR CHAIRS AND TABLES IN A WAY THAT IT LOOKS AND FEELS LIKE YOU'RE ALL SITTING AROUND ONE TABLE, IT'S REALLY POWERFUL."

— DOUG DEMAIO,
YOUNG WRITERS PROJECT

Larner College of Medicine cancer researcher **Julie Dragon, Ph.D.**, is one of many UVM faculty and staff benefitting from UVM's Internet2 connection. She and her colleagues supplement the relatively small number of cancer samples available in Vermont with large downloads of publicly available genomic data — up to eight terabytes a week are possible — from the Cancer Genome Atlas at the National Institutes of Health, giving their analysis of the mutations that may cause the disease statistical validity in the context of the larger population. Each terabit is the equivalent of about 150 DVDs; download times would be impossibly long using the commercial internet.

As crucial as the network was to its faculty, though, University leaders saw that it could also give an information-age slant to UVM's role as the state's land grant

university. When a new National Science Foundation grant program was announced in 2011 to enable Internet2 universities to do just that, UVM saw its chance.

Vermont EPSCoR, a UVM-led research consortium of Vermont colleges, played an integral role in winning the Internet2 grant. EPSCoR applied for and won a \$1 million grant from NSF and hired cyber-specialist **Patrick Clemins, Ph.D.**, to broadly expand UVM's Internet2 connectivity to other institutions in the state.

Clemins became an Internet2 evangelist, meeting with Vermont colleges and universities, school districts, state government agencies and commercial internet service providers, singing the praises of interconnectivity and, once an organization was sold, handing off to **Randy Spooner**, director of UVM's Office of Telecommunications and Networking Services, and his team of network engineers to plot out the technical details of where and how connections could be made.

When all was said and done, all five campuses of the Vermont State College system, St. Michael's College, Norwich University and Vermont state government, including the state libraries, were brought into the Internet2 fold. So were ISP's like Burlington Telecom, Sovernet and FirstLight, who extended the reach of Internet2 to their education and research-oriented customers, including Champlain College, Middlebury College and nearly 80 public schools in eight supervisory unions.

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