

From Coca  
to **CACAO**

**14** After decades of violence,  
a harvest of peace

› **ALSO IN THIS ISSUE**

A Smarter Torpedo  
Startups Get Started  
Help on the Homefront  
Probing the Brain

## Making a Difference

Over the past few years, increasing attention, not all of it positive, has been given to the reliability and societal value of science. Arguments that marginalize or dispute verifiable scientific data appear all too frequently. It is therefore more important than ever that such evidence be clearly communicated and understandable. Nowhere is this clarity more important than in our land-grant institutions, whose very existence is predicated on serving the public good. At Penn State, classes and programs empower our faculty and students by enhancing their ability to explain their science. Our communications professionals work hard to inform policy makers and enhance public understanding of the real-world value of research.

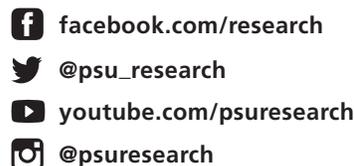
One tried-and-true vehicle for research communication, *Research/Penn State*, has been serving this need for the past 37 years. In this issue, once again, skillful writers working with dedicated faculty bring to life the promise and process of research. Every featured article tells a story of Penn State researchers contributing to the public good; it's not just about knowledge, it's about moving knowledge to impact.

A new generation of smart torpedoes developed in our Applied Research Laboratory is protecting our sailors and our shores. Research scientists in the Clearinghouse for Military Family Readiness work with therapists to enhance quality of life for families enduring the stress of deployment. An engineer and a brain surgeon are building an implantable chip that will advance treatment of many common neurological disorders. And finally, a husband-and-wife team of plant scientists is part of an international effort to promote sustainable cocoa farming as an alternative to coca production in a country long afflicted with drug violence.

Penn State is making a difference: Tell the world.



NEIL A. SHARKEY  
Vice President for Research



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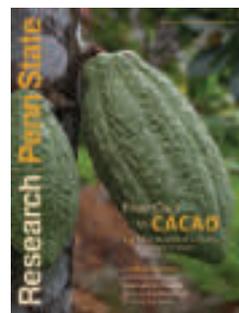
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**ON THE COVER:**  
*Cacao pods ripen in Colombia, where a new program is helping farmers long forced to grow coca learn how to grow cacao instead. See story, page 14. Photo by Camilo Rey.*



PennState





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### In Brief

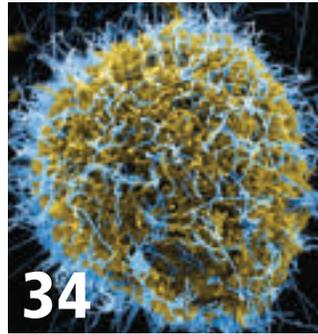
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### From Coca to Cacao

A harvest of peace after decades of drug wars.

David Pacchioli



Devin Edmonds, U.S. Geological Survey

## » Yosemite Frog Comeback

**A** new study shows that after decades of decline, and despite continued exposure to stressors such as pesticides, new diseases, and non-native fish, the endangered Sierra Nevada yellow-legged frog (*Rana sierrae*) is making a comeback.

The frog's abundance across Yosemite National Park increased sevenfold over the 20-year study period—a rare success story at a time when frog and salamander populations worldwide are in steep decline. Wildlife ecologist David Miller, one of the Penn State scientists on the research team, says the finding suggests that given enough

time and the availability of intact habitat, some amphibian species can recover despite the human-caused challenges they still face.

Studies in the East have not yielded such good news. In the past two summers, Miller's lab found ponds in central Pennsylvania where all wood frog tadpoles and all larvae of Jefferson and spotted salamanders died. Miller suspects the culprit was the rana virus, a recently-introduced pathogen that is becoming more common in the eastern U.S. New strains of another pathogen causes the fungal disease chytridiomycosis, the likely cause of

extinction for a number of amphibian species already.

The recovery of yellow-legged frog populations out West is encouraging, said Miller, but if amphibians continue to be buffeted by deadly new pathogens, the outlook for their survival is not bright.

“The global economy isn't moving just goods and services all over the world,” he says. “It is spreading pathogens at a rate we have never seen before.”

—JEFF MULHOLLEM



Since 1991, almost 80 percent of major league baseball players have ranked as overweight or obese based on their body mass index.

- DAVID CONROY

Kinesiology



Climate models good at predicting global changes in temperature and rainfall are not as good at making predictions at regional or local scales.

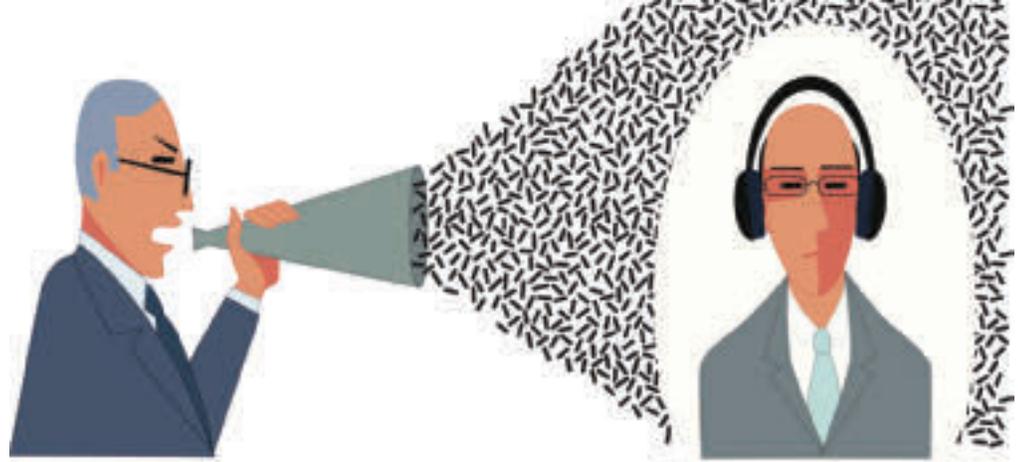
- FUQING ZHANG

Meteorology

&

- MICHAEL MANN

Atmospheric Science



Thinkstock

## Politics May Pollute Support for Pro-Science Solutions

Politically-charged terms in a message about an environmental issue may turn people—even those who know a lot about the issue—away from supporting a pro-science solution, according to advertising and public relations researcher Lee Ahern.

In a study done by researchers at Penn State and the University of Alabama, 964 participants took an online survey on local water quality in the Philadelphia area. They were asked about their political and social worldviews and tested on their general science knowledge and their understanding of storm water runoff issues. Then they read two versions of a report on a water runoff problem and possible solutions. One version of the report attributed the problem to excess rain. The other framed the problem in terms of climate change.

The results showed that Republican participants with high knowledge more strongly supported an environmental solution when the problem was framed in terms of rainfall than when it was presented in the context of climate change. Ahern says the results suggest that politicized terms or concepts in a message can activate readers' political and social beliefs, causing them to oppose solutions they might otherwise have backed.

"This is not unique to conservatives; it works both ways," says Ahern. "It's the framing of the issue that's really important. This is really a message for scientists and science communicators: Don't pollute and politicize the information environment around the issue, because once you do that, people's political identities are going to get engaged."

—MATT SWAYNE

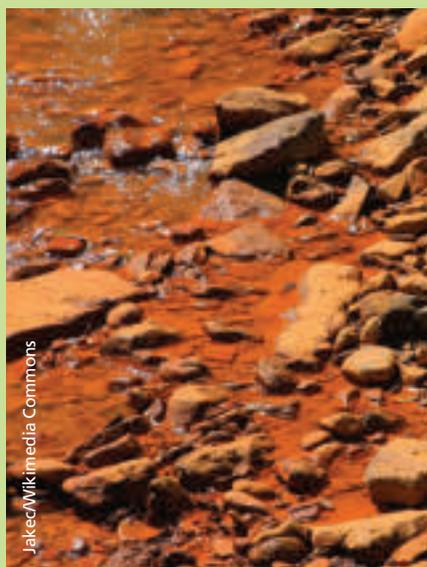
## BACTERIA DETOXYFY MINE RUNOFF <<

Researchers at Penn State are refining a low-cost process using bacteria to remove pollutants from mine-contaminated water.

Runoff from mines is usually acidic and contains metals, such as iron, at levels that make the water highly toxic to aquatic organisms and to people. Some kinds of bacteria, however, thrive in mine runoff by using metal ions in their metabolism, making the water safer for others.

"We researched how quickly ferrous iron was oxidized under set conditions and found out what microbial species lived under these different conditions," says environmental engineer Bill Burgos, who led the study.

The researchers collected bacteria from two acid mine drainage sites in Pennsylvania's Appalachian coal basin and seeded



Jakec/Wikimedia Commons



Stream near a mine in Northumberland County, Pennsylvania

them onto runoff-soaked surface sediments from the two sites. Then they measured how fast the bacteria oxidized iron at different levels of acidity and when iron was present at different concentrations.

Tests showed that while the microbial communities from the two sites were different at the start and remained different throughout the study, they oxidized iron at similar rates. That suggests that the performance of bioreactors for mine-water treatment may not depend on the "microbial seed" used for reactor startup.

The bacteria in the tests were not completely interchangeable, however. Some types did much better when iron concentration was low, and some did much better when the pH was very low (acidic) or high (basic).

—JENNIFER MATTHEWS

## CORALS MAY BE EARTH'S OLDEST ANIMALS ‹‹

Some corals may be the longest-lived animals in the world, according to researchers at Penn State, the National Marine Fisheries Service, and Dial Cordy & Associates. The scientists estimated the ages of individual DNA signatures, or genotypes, in elkhorn corals (*Acropora palmata*) in Florida and the Caribbean. Corals consist of colonies of individual invertebrate animals living symbiotically with photosynthetic algae. Previous attempts to determine the ages of corals have relied on their size, but that can be deceptive; since many corals reproduce by pieces breaking off and starting new colonies, a small colony can be quite old, and old colonies can look younger than they are because they have lost pieces through fragmentation.

Penn State biologist Iliana Baums and her colleagues instead estimated coral ages by using the number of mutations in their genomes as a sort of clock. Because mutations arise at a relatively constant rate, the researchers were able to find an approximate age for the coral genomes in their study.

Their results suggest that some *Acropora palmata* genomes have been around for more than 5,000 years. “This is good news because it indicates that they can be very resilient,” says Baums. “On the other hand, the species we studied is now listed as Threatened under the U.S. Endangered Species Act because it has suffered such sharp population declines, indicating that there are limits to how much change even these very resilient corals can handle.”

—SARA LAJEUNESSE



James St. John/Wikimedia Commons

*Some parasitic weeds can steal genes from their host plant and use those genes against the host.*

- CLAUDE dePAMPHILIS

Biology



Andre-Ph.D. Picard/Wikimedia Commons



Fungal filaments help roots of white pine find nutrients.

### Trees Forage with Fungi

Trees look stationary, but underground their roots, aided by fungal allies, use a surprising number of active strategies to find food, according to an international team of researchers.

Their nutrient-seeking approaches are related to the thickness of the trees' roots and the type of fungi they partner with in shared structures called mycorrhizas, says plant physiologist David Eissenstat. In this symbiotic relationship, the fungi receive carbon from the trees while helping trees acquire other nutrients.

Some trees with thin, short-lived roots, such as maples, seek out nutrient-rich “hot spots” in the soil. Others, such as oaks, produce wide-spreading mycorrhizal strands to find and bring in nutrients. Tree species with thicker roots, such as tulip poplar and pine, send out longer-lasting roots that may miss hot spots but provide a steadier source of nutrients.

Eissenstat compared these nutrient-seeking strategies to financial speculations. “The investment analogy is used quite a bit in ecology because there is this whole idea of cost versus benefit,” he says. Thick roots last longer but cost more to build, and the tree may not recoup its investment. Thin roots don't last as long but are cheap to make, so the tree may have a better chance of a nutritional payoff.

The team conducted the study at Penn State's Russell E. Larson Agricultural Research Center, on plots that kept the root systems of the trees separate.

“In the forest there are a lot of different species of trees, but their roots are all intertwined, so it's hard to know what is really going on,” says Eissenstat.

—MATT SWAYNE



John W. Mosley Photograph Collection, Charles L. Blockson Afro-American Collection, Temple University Libraries, Philadelphia, PA

## » Segregation by the Sea

A chance sighting of black-and-white photos in a Philadelphia gallery window in 2014 led Cheryl Woodruff-Brooks, a graduate student in Penn State Harrisburg’s American Studies program, to discover a special world that flourished from the 1930s to 1960s along the shore in Atlantic City, New Jersey.

The photos, taken by self-taught Philadelphia photographer John W. Mosley, document an intriguing slice of American history in which African-Americans, segregated from the rest of Atlantic City, created their own uniquely attractive haven—Chicken Bone Beach.

“In his own way, he provided America with what we didn’t get in our history books,” Brooks says. “When you look back on that era, you don’t see a lot of pictures of African-Americans having a good time and smiling and laughing and dressing well. He took so many great pictures that really captured what life was like for these people.”

After seeing more of Mosley’s photos at Temple University Libraries in Philadelphia, Brooks explored the history of segregation on Atlantic City beaches and of the Northside neighborhood where many African-Americans lived and worked. She

interviewed people who had visited Chicken Bone Beach, and even discovered that her own uncle had met his wife there. The beach attracted African American celebrities, civic leaders, athletes, entertainers, and tourists from around the United States, as well as whites who were anti-racist or were rejected at other beaches due to their hippie or gay lifestyles.

One woman who had been there about 50 years ago told Brooks she hadn’t even known that Chicken Bone Beach was the segregated beach; it was just “the place to be.”

—KALISHA DEVAN





Flying Puffin, Royal British Columbia Museum/Wikimedia Commons

## » A Mammoth Extinction

**W**hile the Minoan culture on Crete was just beginning, woolly mammoths were disappearing from St. Paul Island, Alaska, according to an international team of scientists who have dated this extinction to 5,600 years ago, plus or minus 100 years.

“It’s amazing that everything turned out so precisely,” says Penn State geoscientist Russell Graham.

St. Paul Island lies about 400 miles north of the Aleutian Islands and was part of the Bering Land Bridge before sea level rose when the last glacial period ended. Mammoths on the continents went extinct around 12,000 years ago but small populations persisted longer in some areas, such as St. Paul Island.

The researchers used sediment cores from an ancient lakebed to determine when the mammoths died out and to document changes in their habitat around that time. Sediment older than about 5,650 years contained spores of fungi that grow on the dung of large mammals. The only large mammals on the island at the time were mammoths. Sediments that age and older also contained mammoth DNA. Younger sediments did not. High-precision radiocarbon dating of the remains of 14 mammoths found on the island helped confirm the date.

The sediments also yielded evidence that the island’s mammoths may have contributed to their own demise. As rising sea levels shrank the island, the mammoths had fewer sources of food



and fresh water. Pollen from the cores indicated that the area around the lake became denuded of vegetation by the mammoths. The resulting erosion probably muddied the water, leading the mammoths to dig holes nearby to reach cleaner water, as elephants do today. That increased erosion even more, further reducing the water supply. The cores show that after the mammoths disappeared, erosion stopped and vegetation returned to the area.

—A'NDREA ELYSE MESSER

*Mobile-phone data on people's movements and communication patterns could make it easier to predict how diseases and ideas spread through a population.*

- DASHUN WANG

Information Sciences and Technology



Presbyterian Historical Society, Philadelphia, PA

Early Head Start class at a rural school.

## Head Start Helped Adults, Too

A federal preschool program gave a head start to more than just African American children in segregationist-dominated Mississippi: It also offered their parents and other adults a route to higher-paying occupations and new leadership opportunities, according to a Penn State historian.

"The idea behind the Head Start program was that we need to prepare kids from working-class backgrounds who perhaps did not have adequate stimulation at home to be prepared for the first grade," says Crystal Sanders, an assistant professor of history and African American studies. "But the idea was also that you can't expect a child from a disadvantaged background to do well if there aren't opportunities for their parents. You have to improve the community in which the child lives."

Head Start grew out of the federal Economic Opportunity Act of 1964, which required programs to operate with the "maximum feasible participation" of the poor.

"Local people had the opportunity to become Head Start teachers, center directors, teachers' aides, and social workers," says Sanders, who wrote about the program's influence on the Civil Rights movement in her 2016 book, *A Chance for Change: Head Start and Mississippi's Black Freedom Struggle*. "These jobs were particularly important in Mississippi, because working-class African Americans typically worked in two fields: They were agricultural workers or domestic servants."

The jobs that opened to them through Head Start brought higher wages, more respect, and economic clout, and freed them from the control of white employers, who had often restricted their political activities, says Sanders.

—MATT SWAYNE

## FIRST ACCURATE SIMULATION OF A VIRUS INVADING A CELL <<

Scientists now know how the shape of a virus changes when it invades a host cell, a finding that could lead to more effective anti-viral therapies.

Researchers at Penn State and the University of Pittsburgh investigated how a virus's protein shell, called a capsid, changes as the virus prepares to inject its genetic material into a cell. In previous experiments, exposing a virus to extreme heat or proteins caused the shape of the entire capsid to change. But Susan Hafenstein, assistant professor of medicine and microbiology and immunology, Penn State College of Medicine, and her colleagues hypothesized that in a real infection, the capsid only changes shape in the region that interacts with receptors on the cell.

To create a more accurate simulation, they mimicked a cell surface

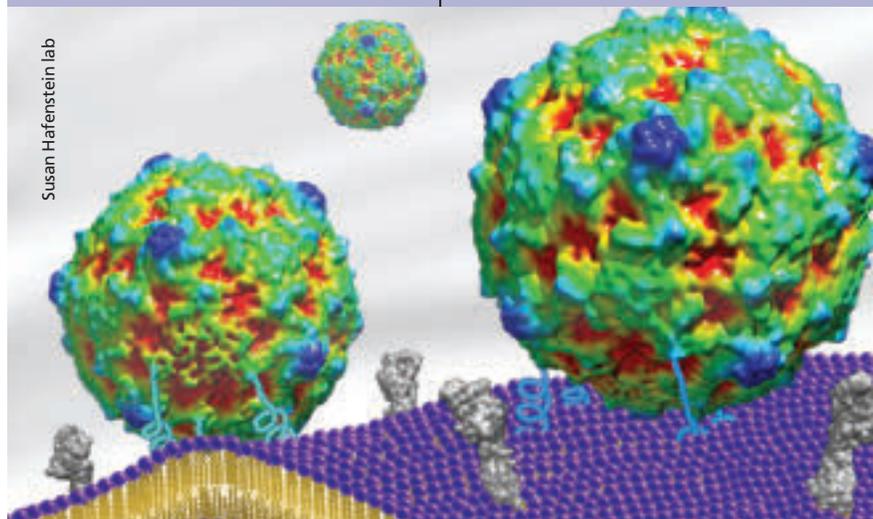
with artificial membranes called nanodiscs, into which they inserted receptor proteins that viral capsids would recognize.

The researchers then added virus capsids to the nanodiscs and used an imaging technique called cryo-electron microscopy to observe changes in the capsids. They saw that the capsids changed shape just where they bound to a receptor.

"A pore opens up only at that one point of interaction with the host cell," Hafenstein says. "That's what's going to set up the capsid to release the genetic material into the cell. We think we have captured the first physiologically accurate virus capsid prepared to enter the host."

The finding could help scientists pinpoint steps in the virus life cycle as targets for anti-viral drugs.

—ABBY SAJID



Susan Hafenstein lab

Viral capsids (colorful balls) attach to an artificial membrane (purple and gold) after binding to virus receptors (gray).

*Combining sign language with speech therapy offers help for children with a rare disorder called apraxia of speech.*

- CHERYL TIERNEY

Pediatrics



### Gene Discovery Could Make Plants More Productive

Scientists have identified a gene that allows photosynthesis to work under far-red light. The finding provides clues to the evolution of oxygen-producing photosynthesis, an advance that changed the history of life on Earth. "Photosynthesis usually ranks about third, after the origin of life and the invention of DNA, in lists of the greatest inventions of evolution," says Donald Bryant, the Ernest C. Pollard Professor of Biotechnology at Penn State and leader of the research team. "Photosynthesis changed the Earth's atmosphere by producing oxygen, allowing diverse and complex life forms—algae, plants, and animals—to evolve."

There are several types of chlorophyll, each tuned to harvest energy from light of certain wavelengths. Most photosynthetic organisms use light in the visible range, with wavelengths of about 400 to 700 nanometers.

The researchers identified the gene that converts chlorophyll a, the most abundant light-absorbing pigment used by plants, into chlorophyll f, which absorbs light in the far-red range of the spectrum (700-800 nanometers). Chlorophyll f occurs naturally in some cyanobacteria, giving them the ability to thrive in conditions where other photosynthetic organisms cannot.

The discovery could enable scientists to engineer crop plants that more efficiently harness the energy of the Sun, says Bryant. "There is nearly as much energy in the far-red and near-infrared light that reaches the Earth as there is in visible light. The ability to extend light harvesting in plants into this range would allow the plants to more efficiently use the energy from the Sun and could increase plant productivity."

—SAM SHOLTIS



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*Female white-tailed deer travel more than twice as far as males when they disperse, complicating efforts to prevent the spread of chronic wasting disease.*

- DUANE DIEFENBACH

Fish and Wildlife Research Unit



*Sloan Digital Sky Survey has yielded a map of 1.2 million galaxies and the sharpest view yet of the properties of dark energy, the force driving expansion of the universe.*

- DONALD SCHNEIDER

Astronomy



## VIRUS HELPS TRACK DEADLY BAT DISEASE ‹‹

Scientists have found a new tool that could help them track the spread of a fungal disease that is decimating bat populations in the U.S.: a virus that infects the devastating fungus.

Regional variations in this virus could provide clues that would help researchers better understand the epidemiology of white-nose syndrome, according to Penn State environmental microbiologist Marilyn Roossinck.

White-nose syndrome, which is caused by the fungus *Pseudogymnoascus destructans*, has killed an estimated 6 million bats in North America since it was first identified in New York state in 2006.



U.S. Fish and Wildlife Service

Little brown bat with white-nose syndrome

Roossinck and her colleagues found that 62 samples of the fungus from sites across the U.S., Canada, and Europe were essentially identical, making it hard to trace how it spread. The virus, however, varies depending on where it came from.

"We believe the differences in the viruses reflect the movement of the fungus, and this viral variability should enable us to get a better handle on how the disease is spreading," says Roossinck.

The virus is not thought to cause disease in the bats, but it may help the fungus produce more spores, which could make the fungus more virulent, Roossinck says.

—CHUCK GILL



Thinkstock

## » Smoke Tolerance Aided Early Humans

**A** genetic mutation may have helped modern humans adapt to smoke exposure from fires, perhaps sparking an evolutionary advantage over Neandertals, according to a recent study.

Both Neandertals (*Homo neanderthalensis*) and modern humans (*Homo sapiens*) used fire for heat, cooking, and protection, but humans are the only primates that carry the mutation that potentially increases tolerance to toxins found in smoke, such as dioxins and polycyclic aromatic hydrocarbons (PAHs). Gary Perdew, the John T. and Paige S. Smith Professor in Agricultural Sciences at

Penn State, says the mutation may have offered early humans a sweet spot in effectively processing some of these toxins.

“If you’re breathing in smoke, you want to metabolize these hydrophobic compounds and get rid of them,” he says. “However, you don’t want to metabolize them so rapidly that it overloads your system and causes overt cellular toxicity.”

The researchers used computational and molecular techniques to examine the difference in the genetics of PAH tolerance between humans,

Neandertals, and a Denisovan, an ancient hominin more closely related to Neandertals than humans. They found that the mutation greatly enhanced the ability of humans to detoxify PAHs.

“If Neandertals were exposed to large amounts of these smoke-derived toxins, it could lead to respiratory problems, decreased reproductive capacity for women, and increased susceptibility to respiratory viruses among preadolescents, while humans would exhibit decreased toxicity because they are more slowly metabolizing these compounds,” says Perdew.

—MATT SWAYNE





## A TRADING PLACE <<

**S** MALL CRAFT PLY THE WATERS OFF the Stone Town district of Zanzibar, Tanzania. For hundreds of years, similar boats carried on extensive trade among ports from India to Oman and Yemen in the Middle East and along the Swahili coast of East Africa. **Janet Purdy**, a doctoral candidate in History of Art and Architecture, took this shot when she visited Stone Town in 2016 to study the trade routes and the massive, elaborately carved doors commissioned by wealthy Omani merchants who lived there in the 19th century (*see back cover*). Zanzibar was a thriving cultural crossroads where people, goods, languages, religions, and artistic practices met and blended. The doors, bearing symbols and decorative elements from many sources, were so important as the public “face” of their owners that they were the first part of a new building to be made.

Photo by: Janet Purdy



Keeping military families strong

# HELP ON THE HOMEFRONT

BY SARA LAJEUNESSE

Thinkstock



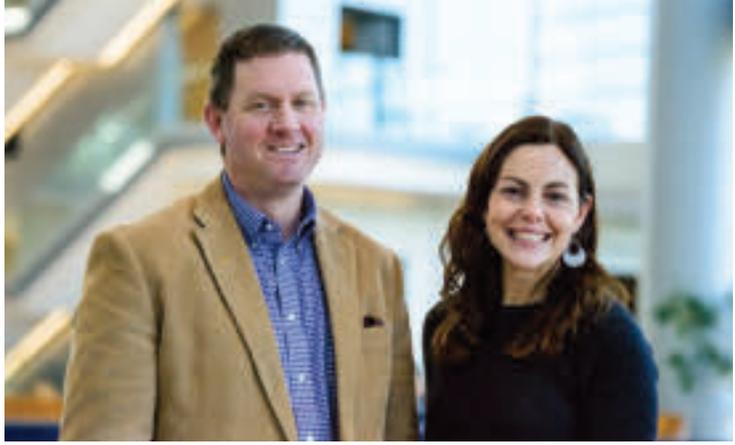
**I**N A FORMAL CEREMONY AT THE PENTAGON, THE WOMAN WAS PINNED AS A FULL COLONEL, A RANK ATTAINED BY LESS THAN 2 PERCENT OF COMMISSIONED OFFICERS IN THE ARMY AND AIR FORCE.

In her distinguished 20-year career, she had served at bases across the globe. but her success had a personal cost: she had caused her family and friends significant worry for her safety, left her husband to manage all the childcare and household duties, and missed her son's entire third year of life.

"Military families are like all families; they have stressors that make it tough to balance work and family,"

says psychologist **Daniel Perkins**. "What's different for them is the added stress of frequent relocations, parental absence with danger factors, and the lack of extended family nearby."

Perkins is director of Penn State's Clearinghouse for Military Family Readiness, which helps therapists and other professionals who work directly with military families to find the best evidence-based practices that address family and mental health issues. It also evaluates the effectiveness of programs being used by the military and provides scientific evidence to military leaders to inform their policies. In short, it bridges the gap between research on the challenges facing military families and the practitioners and decision-makers who help families deal with these problems.



Michelle Bixby

Daniel Perkins and Jennifer DiNallo

The Clearinghouse also draws on research to create its own programs that improve the well-being of service members and their families. In one recent project, Clearinghouse staff evaluated the effectiveness of evidence-based treatments administered to Air Force service members and veterans who suffer from post-traumatic stress disorder (PTSD). According to the Department of Veterans Affairs, up to 20 percent of veterans of the wars in Iraq and Afghanistan suffer from PTSD, yet this study was one of the first to examine how well two widely-used treatments work in a real-world clinical setting.

Using data from the cases of 166 patients at the Wilford-Hall Medical Facility in San Antonio between 2004 and 2014, the Clearinghouse team investigated whether mental health clinicians were implementing two proven methods for treating PTSD; how well the therapists followed the treatment protocols; and the outcomes of the treatments.

They found that about 81 percent of the patients received the treatments, but not all of those got the full, proper form of the treatment. “We found that the interventions worked well in reducing PTSD and other psychological symptoms when the intervention protocols were followed,” says **Keith Aronson**, associate director of the Clearinghouse and of the Social Science Research Institute at Penn State. “But when therapists went off the treatment protocol, patients did not get better. By going off protocol, therapists were unknowingly reinforcing the patient’s avoidance of processing the trauma, which is the real key to treatment.” Upon learning this, the team worked with the Air Force to develop a “protocol adherence checklist” to help therapists deliver the interventions more consistently.

Clearinghouse researchers are also developing a series of programs to improve parenting skills. One of these, called Grow!, is designed for parents of 5- to 10-year-

olds. Research scientists at the Clearinghouse, in partnership with the Department of Defense, examined evidence-based programs for that age range, identified the components the programs had in common, and created a new program incorporating those elements.

“The Grow! parenting program is important because it teaches evidence-informed strategies and skills to parents to help their families thrive,” says **Jennifer DiNallo**, lead research and evaluation scientist at the Clearinghouse. “These are skills that parents will find useful in everyday life.”

The program includes five 90-minute face-to-face sessions with a certified facilitator, and text-based prompts and weekly online videos to reinforce the strategies taught.

In 2016, the researchers pilot-tested Grow! in two civilian communities in central Pennsylvania. “The results were promising,” says DiNallo. “We found that the program has the potential to positively impact parenting practices, stress management, and child physical activity behaviors.”

Now the researchers are testing Grow! at eight military installations around the world. If those pilots go well, the team will make the program freely available online to everyone, not just to military families.

“If you look at the history of this university, we’ve always had a very strong military component,” says Perkins. “As one of the premier land-grant universities in the country, it is part of our mission to translate research into information and products that benefit all of society, including military families. It is part of who we are.”

*The Clearinghouse for Military Family Readiness is housed within the College of Agricultural Sciences.*

As Colombia emerges from 50 years of violence, Penn State experts promote a harvest of peace.

FROM  
**COCA**  
TO

C A C A O

by David Pacchioli



**MARK GULTINAN AND SIELA MAXIMOVA WORK TOGETHER ALL OVER THE WORLD. AS CO-DIRECTORS OF PENN STATE'S ENDOWED COCOA RESEARCH PROGRAM—AND HUSBAND AND WIFE—THE TWO HAVE CHASED THE CHOCOLATE TRAIL FROM GHANA AND PERU TO TRINIDAD AND INDONESIA. STILL, THE EMAIL LAST JANUARY FROM COLOMBIA CAME AS A SURPRISE.**

It was from the U.S. ambassador, asking them to attend a meeting in Bogota in less than a week. Gultinan and Maximova were wanted on a team assembling for a formidable task: to help poor Colombian farmers make the switch from growing coca, the stuff of cocaine, to growing cacao, the principal ingredient in chocolate.

Cacao for Peace, the initiative is called. It's an outgrowth of the historic peace accord signed in November 2016 between the Colombian government and the leftist rebels known as the FARC, or Revolutionary Armed Forces of Colombia, after 53 years of civil war.

In the jungles of rural Colombia, far from the reach of government institutions, the growing of coca—and the violence that envelops the enterprise—has swallowed a generation. For some poor farmers, devoid of opportunity, coca seemed the only option. Others were forced to grow coca and marijuana by the FARC, who used the drug trade to finance their operations. Families who resisted were extorted, murdered, driven from their land in staggering numbers: more than 200,000 dead and six million displaced over the long course of the conflict.

For decades, the U.S. and Colombian governments have tried to stem this bloody tide by choking out illicit cultivation. The first approach was forced eradication of coca plants—basically, scorched earth. More recently, the strategy has shifted to promoting legal alternatives, or what the United Nations calls crop replacement. The end of hostilities brings new urgency to these efforts. Sustainable agricultural development is one of the pillars of the cease-fire document, seen by all parties as essential to Colombia's hopes for a lasting peace.



At a boot camp organized by Penn State researchers in the Santa Marta region of Colombia, a local farmer demonstrates the proper method of opening a cacao pod to release the cocoa beans within. Photo by Mark Gultinan.





Boot camp participants visit a fermentation facility in Santander. Photo by Mark Guiltinan.

## COCOA TO THE RESCUE

In many ways, cacao—a.k.a. cocoa—seems an ideal solution. The Amazon basin, a portion of which falls within Colombia’s borders, is the birthplace of *Theobroma cacao* (literally, the “food of the gods”). The country already produces some of the finest-flavored cocoa in the world. And with global demand for chocolate increasing all the time, the price of its raw material just keeps rising. Guiltinan thinks it could one day be as profitable to grow as coca. A legal crop with that kind of cachet would be a godsend for the country’s rural economy.

On the other hand, cacao is not easy to grow. The plant is finicky and disease-prone; it takes three to five years to produce a crop. Proper fermentation and drying of the beans after harvest is a nuanced art. To make cacao pay, in short, requires hard labor and more than a little know-how, yet around the world most of the stuff is still grown by small farmers with scant access to technology, training, or ready markets.

The ambitious goal of Cacao for Peace is to bridge that gap, or, as Maximova puts it, “to make cacao farming sustainable—profitable for farmers, instead of just a marginal activity.” The larger aim is to make Colombia into a major producer, like neighboring Brazil and Ecuador. Doing so, the thinking goes, would boost the

world’s supply of high-quality cacao, and also benefit the U.S. chocolate industry.

There’s a precedent in a dramatic success story known as the Nebraska Mission. In the early 1960s, the newly formed U.S. Agency for International Development (USAID), looking for innovative ways to promote Colombian agriculture, put together a consortium of land-grant universities with technical and economic expertise. Those experts quickly fixed on floriculture as an opportunity waiting to happen. The result, decades later, is the billion-dollar Colombian export-flower industry that supplies most of the cut flowers sold in the U.S., and creates thousands of jobs in both countries.

“Cacao for Peace is a sort of reinvention of that approach,” says Michael Conlon, agricultural counselor for the U.S. Department of Agriculture (USDA) in Bogota. In the 21st-century version, USDA and USAID have created an international partnership that includes the U.N.’s Office of Drugs and Crime, the Peace Corps, a variety of Colombian agencies, and, crucially, three U.S. land-grant universities with experience in tropical agriculture. Purdue economists are analyzing the cacao value-chain, the processing steps that add value to the bean on its way to becoming chocolate. University of Florida social scientists are looking at cultural factors and rural development. Penn State was tapped for its prowess in the genetics and cultivation of cacao.



**"THE GOAL IS TO MAKE CACAO FARMING PROFITABLE, INSTEAD OF JUST A MARGINAL ACTIVITY."**



Mark Guiltinan

The white criollo bean, prized for its flavor, is native to the Sierra Nevada mountains.

### BOOT CAMP IN THE JUNGLE

On a steamy mid-morning in November, chickens amble through the yard behind the cinder-block headquarters of the farmer's association in Dibulla, a small town along the rural two-lane highway that parallels Colombia's Caribbean coast in the remote Sierra Nevada de Santa Marta region. It's the final week of Cacao Boot Camp, a Cacao for Peace pilot program organized by Guiltinan and Maximova with help from USDA, the U.N., and Fedecacao, Colombia's cacao extension service.

Several factors favored the Sierra Nevada for this inaugural event. The area needed help: It was hard-hit by the civil war, its remoteness attracting illicit agriculture and discouraging, until recently, any government assistance. At the same time, it's a region whose three main ports, Barranquilla, Cartagena, and Santa Marta, provide a sizeable export advantage. Tucked in the shadow of the Sierra Nevada mountains, the world's highest coastal range, it has soils and climate especially well-suited for growing cacao.

"Not to mention the genetic advantages," Guiltinan says. The isolated Sierra Nevada are a biological paradise, home to the *criollo blanco*, the ancient cacao variety first domesticated by the Olmecs, Mayas, and Aztecs. Today, the white or "porcelain" bean is prized by chocolate experts around the world for its aroma and delicacy of flavor. So distinct is criollo from more common varieties that it was once considered a separate species.

The goal of Cacao Boot Camp, Maximova explains, is to "train the trainers," a group of nine farmer-leaders representing three local communities that are already growing cacao, with varying degrees of success. These leaders, and the Peace Corps volunteers assigned to work with them, are getting a crash course in all aspects of cacao cultivation, taught by agents from Fedecacao and other experts. When they return home, they will teach their neighbors what they have learned.

It's also a chance for representatives of all the Cacao for Peace partners to meet and interact, some for the first time. For the camp's initial week, participants gathered in Santander, Colombia's highest producing cacao-growing district, for a vision of what things could look like given better yields and productivity. This week they reconvene 300 miles to the north, in their home region, to apply themselves to the challenges they face.

Smiles are warm as we greet the local farmers. The Dibulla association includes 35 cacao-growing families, many of them previously displaced or shattered by violence. The program begins with a litany of fulsome introductions before the farmers and trainers break into groups. One group heads inside, where a Fedecacao expert is lecturing on *Phytophthora* and frosty pod and witches' broom, the common diseases of cacao. Another group remains outdoors, where a buyer for Cacao de Colombia, a boutique chocolate maker, gives a talk on harvesting and drying.

The small yard teems with activity. A farmer seated on the ground is demonstrating the proper technique for opening a cacao pod. He snatches an oblong specimen from the red and yellow pile between his feet and taps the shell carefully, twice, with his machete, then pries the halves apart to reveal the pale pulp and beans inside. Nearby a woman prepares the communal meal, dropping chunks of fresh meat into a cauldron of boiling broth. The addition of potatoes, plantains, and rice will make the traditional stew known as *sancocho*.

After lunch, a facilitator coaxes the attendees into a circle for an icebreaker. "Part of the idea here is getting everyone to work together," Guiltinan explains. "When we're gone, they're going to have to depend on each other." Getting people together is a large part of what he and Maximova are doing for Cacao for Peace: fostering collaborations between partners and making sure growers can get the sustained technical assistance and the strong, disease-resistant cacao plants they will need to be successful.

As the shy farmers begin to loosen up and laugh, the demographics are striking. There are grizzled old *campesinos*, some without shoes, and there are teenagers, with bright polo shirts, slick haircuts, and skinny jeans, but there aren't many farmers from the war-torn generation in between. Two of the participating communities, Maximova notes, have chosen some of their youngest men to represent them, a gesture that makes her hopeful for their farming future.

Helmer, one of these young leaders, is 18, lanky and thoughtful. He tells of the farm in nearby Alto San Jorge where he and his family grow three hectares



(about 7.5 acres) of cacao along with their other crops. “When we started, we didn’t know how valuable [cacao] was,” he says. Then the war came to their corner of Santa Marta, and Helmer and his family were forced from their land for three years. Now, two years after their return, they are working hard to reclaim it from the pests and diseases that took over in their absence. They hope soon to have 20 hectares planted in cacao. “I am the new generation,” he says, with quiet pride. “I’m here to learn, so that when my moment comes I’ll be ready.”

### DOWN FROM THE MOUNTAINS

The Arhuaco, too, were chased from their homes. Indigenous to the Sierra Nevada, the Arhuaco are descendants of the ancient Tayrona people, and cling to the life of subsistence farming they have practiced for a thousand years. They regard maize and cacao as the gifts of their ancestors.

When the drug trade exploded in the 1980s, Arhuaco land was coveted, first for growing marijuana, later coca for cocaine. Facing intimidation, forced labor, even assassination, many Arhuaco fled into the highlands, where they maintained small family plots of cacao. These days, with the security afforded by an increased military presence, some Arhuaco are moving back down, and bringing their criollo with them.

At a small settlement near a town called Perico Aguado, Arhuaco from several villages gather for a boot camp workshop. Some 60 men, women, and children form a large semicircle in a packed-dirt clearing, grouped in clusters under a towering mango tree. Their traditional white clothing and pillbox hats contrast sharply with the green of the surrounding forest. Twenty paces away, a plain two-story building, nearly completed, stands as proof of the government’s new commitment to development. Constructed by the U.N. with funding from the Colombian government, it will be a much-needed cacao fermentation and drying facility.

Guiltinan and Maximova were introduced to the Arhuaco about a year ago, on their first trip to the region. They have met with the tribe’s leadership several times since. Arhuaco concerns are as basic as not having enough burros to get their cacao to market before it spoils,

Guiltinan says. Yet they’re also eager to learn about plant genetics. “We’ve talked with them about putting together a science team to send into their schools.”

As the *mamo*, an elder and spiritual leader, bids us welcome, his lengthy speech is translated from the Arhuaco language, Ika, first to Spanish, then English. He invokes the tribe’s worldview, which holds that the Sierra Nevada mountains looming behind us are the center of the Earth. His people, he says, have a sacred duty to maintain the ecological balance that exists here. Then one of the younger leaders, a serene-faced man named Hernan, steps forward to tell of what he saw last week in Santander. Valuable technical knowledge, he calls it in Spanish. “We have the culture of cacao,” he says, “but there are some new things we don’t know.”

Though grounded in tradition, the Arhuaco are in some ways quite worldly. Many carry cell phones stashed in their *mochilas*, the bright woven pouches that hang from their shoulders. They are rapidly learning the value of marketing: Cacao de Colombia boasts of using only Arhuaco-grown beans in its world-class chocolates, and Hernan himself recently traveled to Japan to help promote the company’s products.

Today’s workshop, by Arhuaco request, is on pruning, a homelier but no less important topic. “Pruning is the most cost-effective thing these farmers can do to increase productivity,” Maximova says. Fedecacao trainers will demonstrate how to maintain a cacao tree’s proper height and structure, safely remove diseased pods, and allow the right amount of sunlight for pollination and growth.

Such hands-on instruction is a rarity here, Maximova says. “Fedecacao has not had much of a presence in this area before now,” she explains. The agency has only 128 agents to serve 40,000 cacao-growing families across Colombia, so most of its effort has been concentrated in districts that are less remote and better established.

One of the tasks that Maximova and Guiltinan have been assigned for the coming year is to help extend that reach. “It’s about capacity-building,” Maximova says. They have already identified modernizing the agency’s IT systems and its communications with farmers as two areas of need. Last week they invited Dan Tobin, an international development specialist at Penn State, to visit and make his own assessment.



**"WE HAVE THE CULTURE OF CACAO, BUT THERE ARE SOME NEW THINGS WE DON'T KNOW."**





(Clockwise from top left) (1) The Arhuaco people have been living and growing cacao in the Sierra Nevada for over a thousand years. (2) Megan Baumann, a Penn State graduate student in geography, converses with a local farmer. (3) Young farmers, chosen to represent their communities, watch carefully as a cacao expert shows some of the factors that determine fine flavor. Photos by Mark Guiltinan. Opposite page: A young Arhuaco woman and baby attend a workshop on pruning. Photo by David Pacchioli.





As the project goes on, Gultinan says, they hope to involve other Penn State colleagues from various disciplines in order to develop a more comprehensive understanding of the unique challenges these farmers face. “We can’t just think about plants,” the plant scientist is fond of saying. “We need to think about plants, people, planet.”

### “DON’T LEAVE US ALONE”

The final day of Boot Camp brings a throng of visiting dignitaries. Three gleaming white vans disgorge passengers at the community center in Vereda Aguas Frias, home of the Guardabosques of the Sierra Nevada.

Guardabosques (“forest keepers”) is a U.N.-supported program of the Colombian Ministry of Justice that offers funding and technical assistance to rural communities in exchange for a commitment not to grow illegal crops. Five years ago, under this program, coca and marijuana were eradicated from this area, and the community received a grant to replace them with cacao. Since then, however, progress has been slow. Droughts killed off many of the new plantings. A second grant promises an irrigation system, but as of now there’s only enough funding to reach 50 farms, of perhaps 300. “These farmers are struggling,” Maximova says.

U.N. experts maintain that cacao is a good option for this region, and that a successful turnaround here could be a model for the rest of Colombia. But the timing is critical. Coca production, which had declined steadily for the previous decade, has spiked again since the Colombian government stopped its forced eradication efforts in 2014. The peace accord includes a crop-substitution program supported by both sides, but continued cooperation will depend on farmers achieving measurable increases in productivity relatively quickly. Doing that will require a level of ongoing support that has so far been lacking—and one that Cacao for Peace hopes to provide.

On this day, at least, and here in the Sierra Nevada, success seems like a real possibility. Some of the farmers are wary, wondering whether the promised support will continue—“Don’t leave us alone” is a common refrain—but as they show their visitors what they have learned this week, most look determined and hopeful. At a final luncheon at the

spectacular Tayrona National Natural Park, a representative of the government’s newly established Department of Social Prosperity captures the mood, calling what’s beginning to happen in Santa Marta “an example of already living in the post-conflict era.” Cacao, he says, “is a symbol of peace.”

The following morning, headed back to the States, Gultinan and Maximova are pleased and spent, but mostly just keen to maintain the momentum. They hope to start work soon with the U.N. and the Peace Corps to set up demonstration farms, important for diffusing best practices into the surrounding communities. A research symposium in Barranquilla will bring together cacao experts from all over North and South America. And later this year, the two will help lead a first-ever survey of the genetic diversity of cacao in the Sierra Nevada region. [See sidebar.]

There’s lots more in the works over the next five years. For now, though, as we head for the tiny airport at Santa Marta, it feels like Cacao for Peace has taken a solid first step forward.

“We did everything we set out to do,” Maximova acknowledges. “And I think we built up a lot of good will. The important thing is to keep it going.”

*Cacao for Peace is an initiative of the USDA’s Foreign Agricultural Service, with funding from USAID. Partners include the U.N. Office of Drugs and Crime, the Peace Corps, the Colombian Agricultural Research Corporation (CORPOICA), the Colombian National Federation of Cocoa (Fedecacao), the Colombian National Training Service (SENA), and three members of the USDA Land Grant Universities consortium: Purdue University, the University of Florida, and Penn State.*



For more on Cacao for Peace, including video and additional photos, visit [psu.edu/cacao](http://psu.edu/cacao)

(Opposite page) Siela Maximova and Mark Gultinan. Photos by David Pacchioli.  
(This page) A farmer prepares a cacao shoot for grafting. Photo by Mark Gultinan.



## FINDING THE SOURCE

The story of chocolate begins with the ancient criollo, the cacao variety first domesticated by the Olmecs nearly 4,000 years ago. Recent research points to northern Colombia as criollo's birthplace. But where exactly did it get its start? And how and when did it spread?

The answers may lie in the remote highlands of the Sierra Nevada de Santa Marta, a rugged biological paradise and home of the indigenous Arhuaco people. "This is a place where wild criollo trees can still be found," says plant scientist Mark Gultinan.

As part of the Cacao for Peace project, Gultinan and Siela Maximova, co-directors of Penn State's endowed cocoa research program, will join scientists of the USDA's Agricultural Research Service and its Colombian counterpart, CORPOICA, on an expedition to the Sierra Nevada to survey the genetic diversity of the cacao that grows there. Although some surveying has been done elsewhere in Colombia, the Sierra Nevada is uncharted territory.

"This is genomic science combined with geospatial mapping," Gultinan says. "By identifying and locating genetic diversity, we should be able to trace criollo back to its origins, and learn how it has evolved." The team also plans to survey the region's topography, soils, and social conditions.

Much of the data collection and mapping will be done by students and faculty of the National Training Service, or SENA, a network of Colombian professional and technical



colleges. Gultinan hopes to outfit one of SENA's research vehicles as a mobile lab and classroom. But some of the collection range will be too remote for that. "We'll have to go by burro, or on foot, into some of these areas."

The effort will be worth it, he says, and not just for understanding the story of cacao's evolution. Mapping genetic diversity is important for conservation and plant breeding efforts, and could be critical to a new National Science Foundation study that he and Maximova are leading to identify the genes within cacao plants that are responsible for disease resistance.

— DP



Happy Valley innovation hub helps startups soar



Happy Valley Launchbox.  
Photo by Bill Zimmerman

# prepare to launch

BY KRISTA WEIDNER



ONE WALL IN THE BRIGHT, OPEN WORK SPACE OF HAPPY VALLEY LAUNCHBOX SERVES AS A CANVAS for expressing dreams and goals written on a rainbow of Post-It notes and ranging from

general to specific, from serious to whimsical: *Build, and live on, my floating farms. Brain interface for communication. Emma Watson kisses me on the cheek.* An adjacent wall proclaims in bold letters: *Don't quit your daydream.*

Creative thinking is a cornerstone of LaunchBox, a business startup training program that is part of Invent Penn State, a statewide initiative started in 2015 by President Eric Barron. Located in downtown State College, Happy Valley LaunchBox provides free co-working space open to the public, free legal

services to any Pennsylvania startup, and a ten-week Accelerator program that gives Launch Teams—open to both students and members of the wider community—the resources, support, and mentoring they need to increase the chances that their startup companies will find success.

To be accepted into the LaunchBox Accelerator program, teams must present a solid idea for a business that's potentially scalable. "We help them test possible business models," says **Lee Erickson**, director of Happy Valley LaunchBox. "Through mentorship and team meetings, teams share their challenges and get feedback. They begin to notice patterns and see that others are working through the same challenges."

Here, meet five Launch Teams and their projects.



## What's Poppin

When engineering major Joseph Kitonga spent a summer taking classes at University Park, he found himself wondering what to do in his free time. “It was difficult to find interesting, inspiring, engaging events,” he says. He and his friend Azzam Shaikh, also an engineering major, teamed up to create What’s Poppin, a website and app students can use to find out about smaller events on campus and in town.

“Students want to feel they belong,” Kitonga says. “We help them find their niche, their place at Penn State. Everyone knows about the football game or the Kanye West concert—we focus on less publicized events that not only let you meet new and interesting people but create a sense of belonging. We want to capture that community feeling.”

Anyone can create a free account on the What’s Poppin website to view and post events and interact with other users. Most users visit the site two to three times a week to check out new events.

Kitonga stresses that LaunchBox doesn’t guarantee success.

“They provide the opportunity to grow your product. You have to put in the work and the heart and the desire to advance your idea.” [wpoppin.com](http://wpoppin.com)



Lee Erickson, director of Happy Valley LaunchBox, helps budding entrepreneurs turn their ideas into viable businesses.



Graduate student Jessica Menold (below) and recent Penn State graduate Carlye Lauff combined stories about an adventurous little girl with a kit that kids can use to build a cardboard rocket ship (bottom). All photos by Patrick Mansell.



## Curiospace

Jessica Menold, a Ph.D. student in mechanical engineering, came to LaunchBox with an idea combining two very different disciplines: engineering and child development. Through 3D-printed brackets and interactive story books for children, she and cofounder Carlye Lauff are working to bring engaging and educational experiences to Syrian children in refugee camps in Germany.

The project, Curiospace, grew out of Menold’s visits to refugee camps two years ago. “I spoke with parents and children,” she says. “The kids don’t have much to do—often they can’t go to school. I wanted to help, and I wondered what we could send to camps that would work with what they have.”

Menold and Lauff worked with Meg Small, director of the Health and Human Development Design for Impact Lab in the Bennett Pierce Prevention Research Center, to pair the idea of stories and a building kit. They’re creating a series of stories about Nazira, a little girl who has adventures. The stories incorporate elements of the Good Behavior Game, a simple game that focuses on emotion regulation and is proven to benefit children with high levels of stress.

“The stories end with a build activity,” Menold explains. “In the first book—which was published in Arabic, English, and German—Nazira’s spaceship breaks down and she asks the kids to help her build a new one.” Using cardboard and the brackets that Menold and Lauff created, children construct a spaceship.

“The kits give kids just enough structure, while allowing them to be creative,” Menold says. “We want to give kids a chance to play in a way that’s conducive to social/emotional development and that fosters creativity.”





Senior Ben Sparango (above) and Matt Mason started a service to prepare and deliver meals for students too busy or tired to cook for themselves. Photos by Patrick Mansell.



## Stockd

When senior Ben Sparango went home for a weekend to cook “a bunch of lasagna” with his mom, it wasn’t because he’s overly interested in the culinary arts. Sparango, a mechanical engineering major, was gearing up to test his new business model.

A couple of years earlier, Sparango and his friend Matt Mason had an idea to start a grocery delivery service to off-campus Penn State students. “But we soon realized we were addressing the wrong problem,” he says. “Students didn’t have trouble getting groceries—they had trouble finding time to cook.” With guidance from LaunchBox, the students re-tooled and created Stockd, “The meal plan your mother would approve of.”

After his cooking weekend, Sparango brought a dozen lasagna meals back to campus and gave them to students, asking for their feedback. “I wanted to know if it seemed like something Mom had made, if they’d be interested in the idea of regular meal delivery,” he says. “We got good feedback. A lot of students said it would be worth it not to have to cook or order out multiple times a week.”

Sparango and Mason credit LaunchBox with providing the momentum for Stockd: “When we applied to LaunchBox we were at a standstill,” Sparango says. “This place is 100 percent why we’re this far along.”

<https://readymag.com/igordyakov/STOCKD/>



## OmegaNotes

OmegaNotes, an online notes marketplace, was born out of an all-too-familiar scenario for college students.

“I was studying for a biology exam, and I realized I was missing an entire chapter of notes,” says founder Drew Lang. “I must have deleted them by accident. I had nowhere to go. The idea came to me within two minutes: There might be a marketable solution to this problem.”

Lang, who recently received an MBA from Penn State Behrend, began researching the concept at the Innovation Commons there and further developed it with the help of Happy Valley LaunchBox. On the OmegaNotes website, students can buy and sell: Shoppers search by professor, course, or subject; sellers upload their notes and get paid immediately for each transaction.

OmegaNotes recently started offering a faculty-to-student component as well. “We offer digital, customized course packs,” Lang explains. “If a professor wants three chapters out of a textbook, a couple of YouTube videos, eight quizzes, and slides, we can do that. It’s a much cheaper option than printed course packets.”

The site can also provide faculty with analytics that aid peer-to-peer learning. “We can tell the professor, ‘John understands Chapter 1 but is unsure about Chapter 2. Sally is struggling with Chapter 1 but she completely gets Chapter 2. They should study together.’ The data is unlike anything else in the marketplace.”

[omeganotes.com](http://omeganotes.com)



## Maake

“A way to make sure that art is seen.” That’s what Emily Burns and cofounder Daniel Collins are providing with Maake, a contemporary art resource that encompasses an online gallery, print magazine, and curated exhibitions and events.

Burns, an MFA student in graphic design, is using Maake as a platform to showcase the work of emerging artists. Maake’s goal is to exhibit innovative and experimental contemporary artwork, as well as to foster conversation and community. “You can’t function without a community and dialogue, and the internet has opened up so many opportunities for different art worlds to tap into,” she says. “There’s a lot of work out there that should be seen but that hasn’t gotten gallery representation, so we promote artists via social media, our blog, and our magazine.” Through Maake, Burns has also curated several art exhibitions featuring artists from across the country.

Burns appreciates the opportunity LaunchBox provides to work with other young entrepreneurs, share ideas, and learn how others solve problems. She’s also gained essential knowledge about running a business. “LaunchBox is fantastic,” she says. “The world of entrepreneurship—the lingo and terminology and the concepts behind them—was foreign to me, but so important for the arts. To be able to put a name to a concept and talk about it with people who really know what they’re doing is invaluable.”

[maakemagazine.com](http://maakemagazine.com)



Master of Fine Arts student Emily Burns and musician Daniel Collins founded an art resource comprising an online gallery, print magazine, and curated exhibitions and events. Photos by Patrick Mansell.



*Invent Penn State is a statewide initiative to spur economic development, job creation, and student career success. It blends entrepreneurship-focused academic programs, business startup training and incubation, funding for commercialization, and university-community collaborations in a variety of programs that support early-stage enterprises and help turn research discoveries and new ideas into valuable products and services.*

*In addition to the Happy Valley Launch-Box, Invent Penn State has provided seed-grant funding for similar innovation hubs in 12 other Commonwealth campus communities around the state. Each hub offers staff, students, and members of the community help in developing product and marketing ideas, navigating intellectual property laws, and finding investors. In 2016 the innovation hubs helped launch 48 startup companies.*

Learn more at [invent.psu.edu](http://invent.psu.edu).



LaunchBox director Lee Erickson (center) guides new participants in the Accelerator program through the many challenges they face when starting a new business. Photo by Patrick Mansell.

## New torpedo hunts solo— for another torpedo



# FIRE AND

# FORGET

BY CHERIE WINNER

**T**orpedoes are a lot smarter than they used to be. Originally, torpedoes weren't too bright. They went where they were aimed, but couldn't change course to follow a target. Later, sonar let them home in on a ship's acoustic signals. That made them a little smarter, but they could be fooled by ship-mimicking signals.

In the 1980s, the Soviets brought out a torpedo that shot to the head of the class. Instead of looking for a ship, it uses upward-looking sonar to detect a ship's wake. When it finds one, it zigzags from one side of the wake to the other until it reaches its target. The ship can't take evasive action because wherever it goes, its wake follows. And because the torpedo is not tracking the ship's noise, it can't be diverted by phony ship-sounds.

Now, the U.S. Navy has a potential defense against this threat: an even smarter torpedo. Designed at Penn State's Applied Research Laboratory, the Countermeasure Anti-Torpedo Torpedo, or CAT, is part of a defense system that can find and destroy a wake-homing torpedo. When a sensor array towed behind the ship detects an incoming threat, the CAT is launched. From then on, it's on its own—"fire and forget," says acoustics scientist

**Russell Burkhardt**, director of ARL's Undersea Systems Office.

"It goes out with its own sensors, searches, determines its own targeting, and makes decisions on how to maneuver," says retired Naval officer **Gary Watson**, who has managed the CAT project for the past year. "The level of technology in the vehicle, nose-to-tail, is light years ahead of other torpedoes in our fleet. This is probably the smartest torpedo that's ever been produced."

Perhaps as impressive as the torpedo itself is the way it was developed—and how fast ARL got it into the water.

The Lab had already done some work on an anti-torpedo torpedo when, in December 2011, Chief of Naval Operations Admiral Jonathan Greenert gave them the full go-ahead on the project—with a catch.

"He challenged us to deploy this within roughly 24 months," says Burkhardt—which meant building and testing a prototype themselves rather than having the Navy put it out for bids by industry. "We had to finish our design, then go through all of the testing that has to be done to prove that the weapon is safe for the sailor," says Watson.

Right: The CAT was made using modular design and extensive simulations, which speeded the process and cut the cost of the project. Opposite: Test-firing the CAT from supercarrier *USS George H.W. Bush*.



That urgency drove many of the innovations in how the vehicle was made, such as using simulation-based design to test and refine their ideas. “Simulations allow you to quickly assess a design without building it and testing it in water, which can be very expensive and take time,” says Burkhardt.

Simulations also made it possible to design all the sections of the torpedo—each carrying different components such as the power supply or navigational instruments—independently. That meant the sections could all be worked on at the same time, rather than following the usual, more time-consuming process of working on one at a time. If one section was ready for testing before the others, the simulation filled in the missing pieces.

To top off this modular construction process, the team came up with a new way to put all the sections together. Rather than being connected by cables, as with other torpedoes, the CAT’s communications and electrical connections at the ends of each section are joined by pins in what’s called a “blind mate” arrangement: The operator doesn’t need to see the pins to align and connect them.

As well as saving time, doing so much of the design via simulations trimmed costs. “This is one of the most inexpensive weapons, given what it is,” says Watson. “Compared to any of its predecessors, it’s probably a half to a third of

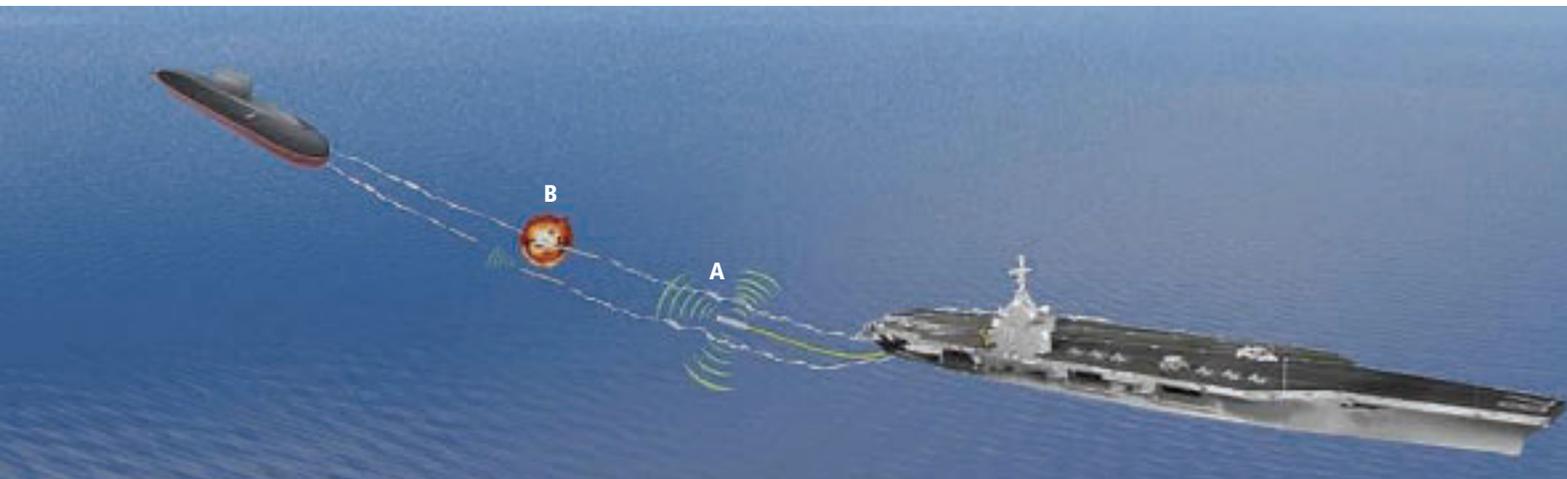
the cost—*because* of the way it was designed, *because* of how easy it is to assemble.”

Once they built physical prototypes of key pieces of the vehicle, the group began tests in ARL’s water tunnel, one of the best facilities of its kind in the country. After live trials at sea, the new torpedo defense system began a test deployment on the supercarrier *USS George H.W. Bush* in March 2013. It has now been installed on four other ships.

Although the ARL has been one of the Navy’s go-to partners for research on undersea weapons systems since the mid-1940s, its story is not well known, says Burkhardt, in large part because much of its work is classified, and employees simply can’t talk about it.

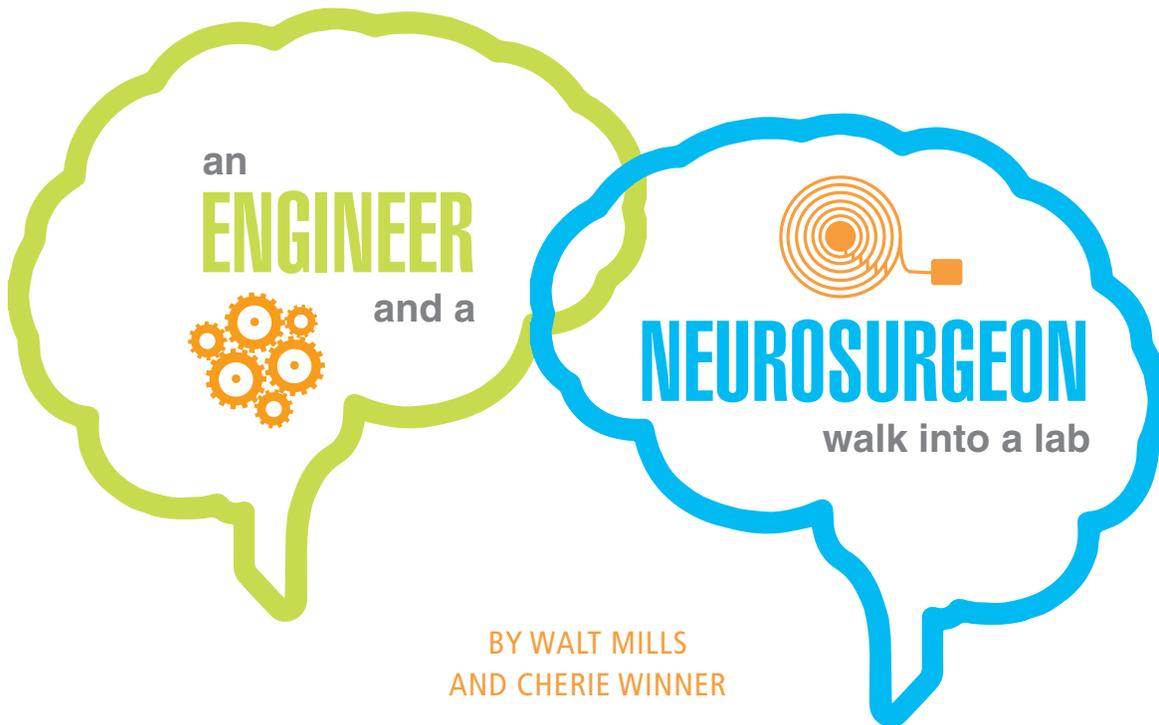
That restriction also means that the engineers and scientists who worked on the CAT—250 individuals, at the project’s peak—can’t do one of the major things university researchers are expected to do. “They’re not allowed to publish,” says Watson. “They give up that opportunity when they come here to work on these projects.”

“There’s a lot of pride with this group, and we love talking about it,” says Burkhardt. “It’s important for people to know that we are doing good things here.”



When an acoustic sensor array (A) towed behind a ship detects an approaching torpedo, a human operator on the ship fires the countermeasure anti-torpedo torpedo (CAT), which finds and “kills” the incoming torpedo (B). Distance is compressed in this image. All images courtesy of Applied Research Laboratory.

## Developing an implantable device to tackle diseases of the brain



BY WALT MILLS  
AND CHERIE WINNER

**S**TEVE SCHIFF HAS THE SOOTHING VOICE AND GENTLE MANNER OF SOMEONE WHO HAS SPENT A LARGE PART OF HIS CAREER DEALING WITH CHILDREN, AND FREQUENTLY, CHILDREN IN PAIN.

As a pediatric neurosurgeon, he has lent his skills and bedside manner to treating diseases of the brain in children. As a researcher, he is joining forces with electrical engineer **Srinivas Tadigadapa** to develop technology to understand and treat diseases of the brain.

Schiff is director of the Penn State Center for Neural Engineering, a lab that takes up an entire floor of the Life Sciences wing of the Millennium Science Complex on Penn State's University Park campus. A series of card-swipe controlled laboratories make up the 11,000-square-foot Center, which includes facilities for the construction of custom electronics, live animal imaging and surgery, and advanced computerized microscopy.

In the Materials wing of the building, Tadigadapa's group is developing microelectromechanical systems (MEMS) that allow miniaturization of devices that can sense and stimulate nerve cells, some of which the team hopes will one day be implanted into the human skull in order to explore the brain on a cell-by-cell basis.

➤ Electrical engineer Srinivas Tadigadapa and neurosurgeon Steve Schiff have joined forces to create a device that can interact with brain cells without invading the brain.





Monitoring Kidney Function Based on Urinary Cr...  
Shanil Durrani, Sun-ye Heung, et al. W. Brian Stetson, and the  
Department of Electrical Engineering and Biotechnology, The Pennsylvania State University

**Abstract**  
This research is a part of a larger project to develop a portable, low-cost, and easy-to-use device for monitoring kidney function. The device is designed to be used in a clinical setting and is based on the principle of...  
The research work is supported by the National Institutes of Health (NIH) through a grant to the Pennsylvania State University.

**Principle of Operation & Images**  
The device is based on the principle of...  
The device is shown in the following images.

**Figure 1: Schematic Diagram of the Device**  
The schematic diagram shows the internal components of the device, including the sensor, the microcontroller, and the power source.

**Figure 2: Photograph of the Device**  
The photograph shows the physical device, which is a small, rectangular box with a display screen and several buttons.

**Figure 3: Graph of the Device's Performance**  
The graph shows the device's performance over time, with the y-axis representing the measured value and the x-axis representing time.

**Conclusion**  
The device is a promising tool for monitoring kidney function in a clinical setting. It is portable, low-cost, and easy to use. Further research is needed to improve the device's accuracy and reliability.



Wikipedia

◀ Bone from the top of a human skull has a dense outer layer (top), a dense inner layer, and a spongy-looking middle layer. A tiny magnetic device placed on the inner layer will be able to stimulate and sense brain cells without injuring the brain or exposing it to infection.

The Millennium Science Complex was built with the concept of integrating the expertise of materials scientists, electrical and mechanical engineers, and nanotechnologists, who occupy the north wing of the building, with medical and biological researchers, who occupy the building’s west wing.

“This building reflects our interaction, because we are half materials science and half life sciences,” Schiff says. “We will literally build these technologies on one side and walk them up the stairs to our lab where we do experiments on neurons. We will use individual neurons that we will be recording from and stimulating to see how far we can push this technology. We are, to our knowledge, the only center at present that is in a position to manufacture these high density arrays for sensing and stimulation in a nanofabrication facility and then literally transition them to an operating room.”

### STIMULATING THE BRAIN

The project is funded by the National Institutes of Health through the BRAIN Initiative, a program launched in 2013 by President Obama to accelerate the development and application of new technologies to investigate how individual brain cells and complex neural circuits interact.

In addition to graduate students, research associates, and others at Penn State, the research team includes John Wikswa of Vanderbilt University, who is one of the world’s leading experts on magnetic fields in neurons. “John provides some of the key physics expertise that no one else in the world has,” Schiff says.

The group’s goal is to develop a MEMS device capable of measuring the activity of individual brain cells and stimulating those cells without physically penetrating the brain—a technology that could provide long-term benefit for individuals with any of several debilitating neurological disorders.

For the past 70 to 80 years, scientists have been using electrodes on the surface of the brain to measure

electrical currents, and, since the 1950s, to stimulate the brain. More recently, an approach called deep brain stimulation (DBS) was developed as a means to treat the tremors associated with Parkinson’s disease. In DBS, electrodes are implanted in the brain and a generator is implanted in the patient’s chest wall. A pattern of electrical pulses is used to stimulate portions of the brain. Now, DBS is being studied experimentally as a method to treat a variety of other ailments. It works for some patients with major depression, although the exact mechanism is still unknown. DBS has also been used to control robotics for patients with disabilities.

“Imagine you are trying to run an artificial hand,” says Schiff. “You want to pick up signals from the hand area of the cortex to give you the intention of the individual to move such a hand. We can only do that now by implanting arrays of electrodes into the hand area of the brain itself.”

A big drawback of the technique is that implanting electrodes deep inside or onto the surface of the brain has serious potential side-effects.

“There is a measurable risk of hemorrhage and damage, and there is always a few percent risk of infection,” says Schiff. “If I’m studying a child for epilepsy, I need to take those electrodes out by two weeks, definitely by three weeks, or I have to go in and free them from the scar tissue that’s already formed on the surface of the brain.”

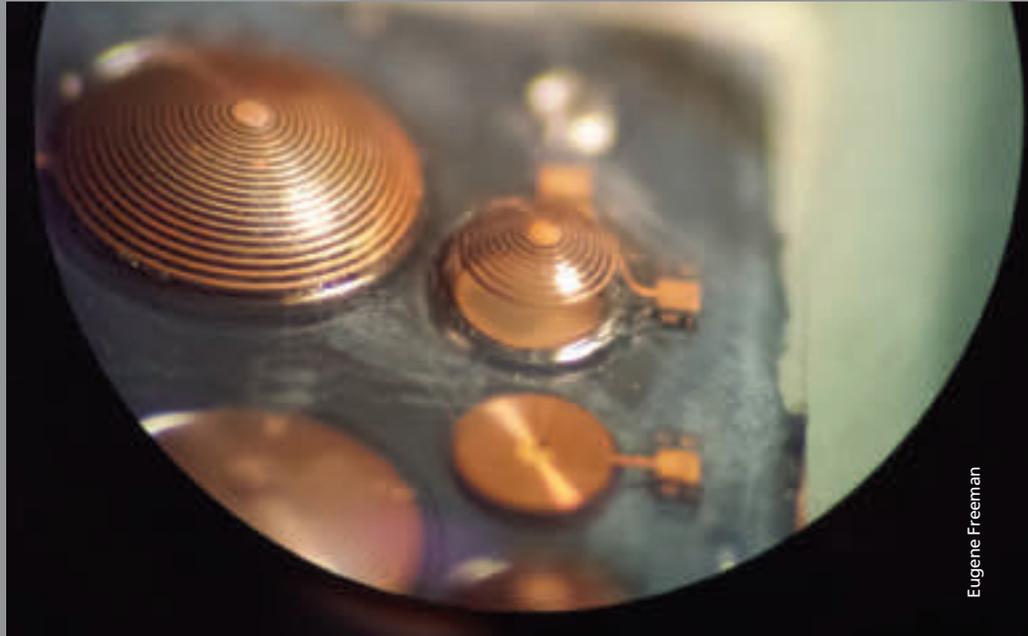
### A PENETRATING INSIGHT

Placing electrodes on the outside of the head is not a good option, either, because bone is a good insulator and electrical signals cannot easily pass through the skull. There is a better choice: using magnetic fields rather than electrodes. Bone is not a barrier to magnetic fields as it is to electrical signals. That’s where Tadiadapa’s expertise comes in. He and his lab team are developing tiny MEMS devices that can interact with brain cells via magnetism.

“EVEN A FRACTION OF A MILLIMETER MAKES A DIFFERENCE.”



Courtesy of Srinivas Tadigadapa



Eugene Freeman

(Left) Helmholtz coils made of copper wire apply a magnetic field to a small magnetoelectric magnetometer to calibrate it. The magnetometer senses magnetic fields; this one is designed to detect the fields generated by neurons in the brain. (Right) View through a microscope of microcoils developed in the Tadigadapa lab. Each coil, made of copper patterned on glass, creates a magnetic field that produces an electric current in targeted brain cells.

But magnetic fields come with a problem of their own: They decrease with distance—“Even a fraction of a millimeter makes a difference,” says Tadigadapa—so to get their device as close as possible to the cells it will interact with, the team is taking advantage of the layered structure of the bones that enclose the brain. These bones have a dense outer layer, a dense inner layer, and a spongy-looking layer in between. By removing a small piece from the outer and middle layers, researchers can place a device on the inner layer. This gets the device as close to the target cells as possible without penetrating the dura, the tough membrane that surrounds and protects the brain from infection. The device could be adjusted, repaired, or replaced without disturbing brain tissue.

Using magnetic fields to affect the brain is not new. What’s new and ambitious about the Penn State project is that the researchers will attempt to stimulate and record the activity of small groups of neurons—the smallest group that would be effective for producing a desired result—or even of single nerve cells.

“Usually what people do to magnetically stimulate neurons is to have very big coils that go outside the head,” says Eugene Freeman, a Ph.D. candidate in Tadigadapa’s lab. “They’re not implantable. They’re about the size of your fist, so you have to go in to a lab for the treatment, which is called transcranial magnetic stimulation. These large magnets activate a relatively large part of the brain. You can’t get fine specificity.”

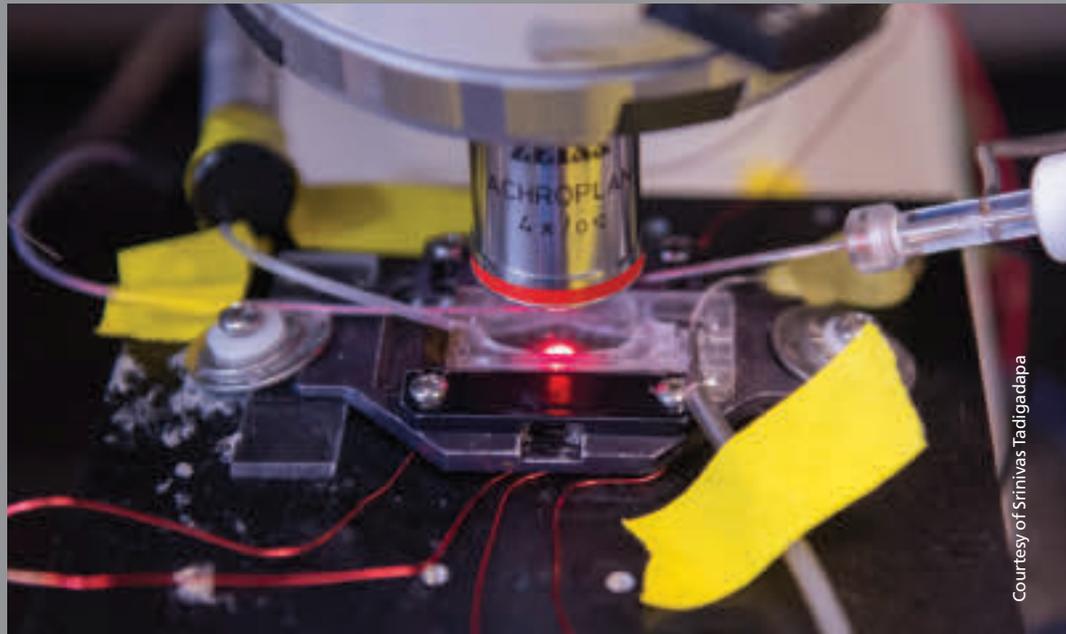
Freeman is experimenting with magnetic field-inducing microcoils of different sizes and shapes, the smallest so far being about half a millimeter in diameter. Each coil creates a magnetic field that can create an electrical current in one or a small number of targeted brain cells.

The coils are made with copper patterned on micro-glass structures. The team is also taking advantage of recent advances in three-dimensional fabrication to look into whether a 3D coil might be more effective than a flat coil.

“THERE IS NO OTHER TECHNOLOGY THAT CAN WORK DIRECTLY WITH THE MOTOR AND SENSORY REGIONS OF THE BRAIN, YET LAST A LIFETIME.”



Patrick Mansell



Courtesy of Srinivas Tadigadapa



(Left) Doctoral candidate Andrew Whalen examines a sample of rat brain tissue. (Right) The living sample allows researchers to understand the strength of signals coming from individual brain cells and the magnetic field strength needed to influence those cells.

### MORE CHALLENGES

Recording the magnetic fields generated by neurons is a tougher challenge than stimulating the cells, says Tadigadapa. Conventional methods of doing this without potentially damaging the brain either don't have cellular resolution, require shielded rooms, or cannot be performed at safe temperatures—one technique requires cooling to liquid helium temperatures (-269 degrees C) and another requires heating to 180 degrees C. A recently developed method uses a synthetic diamond material to pick up very small magnetic fields, but it requires using microwaves, like the ones in a kitchen microwave oven, which have a tendency to cook things in the vicinity. Not an optimal solution.

Then there's the seemingly inescapable problem of living on a planet that is itself a huge magnet.

“The Earth's magnetic field is around 60 microTesla,” says Tadigadapa, referring to the standard unit of measurement, “and the magnetic field of human brain activity is around a picoTesla, around 60 million times weaker. So there is need to block Earth's huge magnetic

field. Currently that is done within an isolated room that costs several millions of dollars to build. We hope to be able to do it with an on-chip circuit.”

He proposes to build active and passive circuits on a microchip that will cancel out magnetic noise using a simple feedback loop, the same technique used in noise-cancelling headphones. The microdevice will generate an on-board magnetic field within the MEMS chip that will compensate for the Earth's magnetic field and other interfering magnetic fields in the nearby environment. Other circuits in the implantable chip will amplify the magnetic signal from the cells.

“We have a number of designs that Srinivas is going to be placing on these chips,” says Schiff. “They operate at ambient temperature, which means they assume the temperature of their surroundings, rather than freezing them by being dropped into liquid helium. And when implanted, they will allow us to take this technology out of the laboratory for the use of people in an ambulatory setting.”

“It's a good technical challenge,” says Tadigadapa with a smile.



Srinivas Tadigadapa (left) and Steven Schiff are developing a microelectromechanical device that can measure the activity of single brain cells and stimulate those cells without physically penetrating the brain, a technology that could benefit individuals with neurological disorders such as epilepsy and ALS. Photos by Patrick Mansell.



## PUTTING IT INTO PRACTICE

Schiff, who is also professor of neurosurgery, says he and many of his colleagues at Penn State Milton S. Hershey Medical Center are excited about the potential of this new technology to help patients with a range of neurological problems, including spinal cord injuries, ALS, stroke, and cognitive disorders such as depression and obsessive-compulsive disorder.

“I’ve worked in epilepsy for most of my career,” Schiff continues. “This is a way to potentially not only sense from a part of the brain that makes seizures, but to modulate the activity to prevent seizures.”

Being able to stimulate and sense neuron activity without penetrating the brain will be especially valuable to individuals with long-term needs, he adds.

“If I have someone like one of our young veterans who has lost an arm, you want him or her to be able to run a prosthetic device for 50 years. You need to be able to maintain the device, not damage the patient any further through repeated brain surgeries, and importantly, you need a way to give sensory feedback to the brain. This is a way to interact with the brain and to give it signals reflective of what a prosthetic is sensing as it touches something.”

Schiff and Tadigadapa are making rapid progress toward that goal. A great deal of the physics of identifying magnetic signatures in the brain has been worked out by John Wikswa, and the resources of the Penn State Nanofabrication Laboratory will enable them to make very small, high-density arrays of sensors and stimulators. Their experimental devices have already achieved sensitivity in the range of 300 picoTesla at room temperature.

“The first chips will probably be on the scale of a centimeter for the part of the chip that just does sensing,” says Schiff. “For implantation, the scale we are targeting is 100 micrometers. We won’t be submillimeter for the array the first two years.” With the progress they’ve made so far, he and Tadigadapa can make a strong case for funding for the next stage of the work, further miniaturizing and refining the devices through multiple rounds of experiment and nanofabrication.

Initial testing with living tissue is being conducted on slices of rat brain, to understand the strength of signals coming

from neurons and the magnetic field strength required to stimulate nerve cells, and whether it is necessary to use single cells or whether they can produce the results they want with a small number of cells. Andrew Whalen, a doctoral candidate in mechanical engineering, and postdoc Herve Kadji are working with Schiff to prepare these experiments using the micro-magnetic coils that Eugene Freeman has designed. Because there are billions of neurons and other types of cells in the brain, the team will need to develop mathematical “filters” that can help them distinguish one type of cell from another.

The first devices they test with human subjects will be too large to implant due to the amount of electronics and chip packaging necessary, so they’ll be placed on the outside of the skull. That will allow the team to measure the person’s magnetoencephalogram, a map of brain activity based on the magnetic fields produced by brain cells. Even at that size, the device can be very helpful in evaluating epilepsy patients, says Schiff.

“We also can perfect our adaptive noise cancellation, which is key to enabling us to operate without expensive shielded environments,” he says. “So we can test and get the bugs out of this technology before we go to implanted devices.”

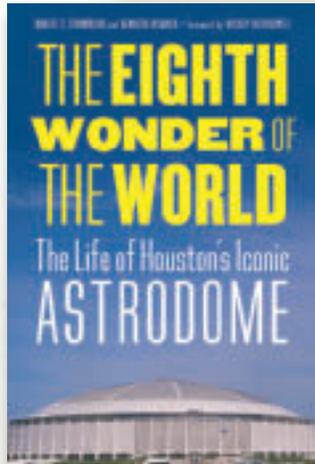
When the electronics packaging issue is solved, Schiff expects to have a biocompatible array that has the desired sensitivity and strength and is small enough to be placed in a shallow trough in the skull, where it is as close to the target cells as it can be without penetrating the brain.

It’s an ambitious project, but their progress so far makes Schiff optimistic that they will have a working device in the near future—and that it will offer patients, and their doctors, something that has not been available to them before.

“There is no other technology that can be implanted and work directly with the motor and sensory regions of the brain, yet last a lifetime.”

*Steven Schiff is Brush Chair Professor of Engineering, professor of neurosurgery, professor of engineering science and mechanics, professor of physics, and director of Penn State’s Center for Neural Engineering. Srinivas Tadigadapa is professor of electrical engineering and biomedical engineering.*

# BOOKS



## THE EIGHTH WONDER OF THE WORLD: The Life of Houston's Iconic Astrodome

by Robert Trumbour, associate professor of communications, Penn State Altoona, and Kenneth Womack, 2013-14 Penn State Laureate

When the Houston Astrodome opened in 1965, promoters dubbed it the “Eighth Wonder of the World.” In their new book by that name, co-authors Robert Trumbour and Kenneth Womack, now at Monmouth University, detail the building’s decades of history — architectural, sports, and cultural. The Astrodome closed in 2002, and its future is uncertain. But it will always have a place in history.

The first of the modern domed stadia, the Astrodome required new technologies for dealing with the forces that play on large structures. Some of its engineering designs were precursors of those later used for the World Trade Center. The stadium spurred other innovations as well. Because the glare from the Lucite roof prevented ballplayers from seeing fly balls, the roof was painted over. Without sunshine the grass inside the Astrodome died, necessitating the invention of AstroTurf.

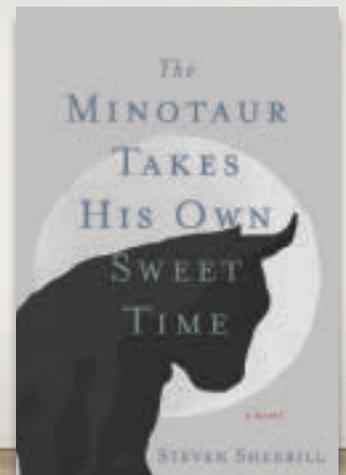
The Society for American Baseball Research awarded this book the Seymour Medal as 2016’s best book of baseball history or biography.

## THE MINOTAUR TAKES HIS OWN SWEET TIME

by Steven Sherrill, associate professor of English and integrative arts, Penn State Altoona

Steve Sherrill’s novel, *The Minotaur Takes His Own Sweet Time*, revisits a character Sherrill introduced 16 years ago in his first novel. “M,” the minotaur of Greek mythology, has moved from the American South to an economically depressed community in south-central Pennsylvania. He’s now a professional Civil War re-enactor at a living history park, dying on cue during scripted battles, but his personal struggles remain unchanged. He’s isolated, lonely, pondering his half-human, half-bull nature, cared for by the immigrant family that runs the motel where he lives, tolerated by most of his neighbors and coworkers, but tormented by some.

When Holly and her damaged brother arrive on the scene, dealing with losses of their own, they stir hopes in the Minotaur that he might finally find love, understanding, and genuine human relationship.



## ROBOTS

by John Jordan, clinical professor of supply chain and information systems

How are robots affecting our businesses and personal lives, and what changes can we look forward to as robots take on even larger roles in both? Technology analyst John Jordan discusses our expectations of these mechanical, quasi-intelligent helpers in *Robots*.

Robots have become commonplace in our homes—Roomba, for example—and in the news—notably, the military use of drones. Meanwhile, for most of us the main sources of information about robots are the fantasies of popular culture. We know a lot about C-3PO and RoboCop but not much about Atlas, Motoman, Kiva, or Beam—real robots that are reinventing warfare, the industrial workplace, and collaboration.

Robots will be neither our slaves nor our overlords, writes Jordan; instead, they are rapidly becoming our close companions and partners. Given this profound change to human work and life, Jordan argues that robotics is too important to be left solely to roboticists.



## BY PENN STATE FACULTY



### THE FISHES OF PENNSYLVANIA

by Jay Stauffer, Distinguished Professor of Ichthyology

It took 32 years for ichthyologist Jay Stauffer to publish his landmark book, *The Fishes of Pennsylvania*. But scientists, educators, naturalists, and fish enthusiasts will find the compendium worth waiting for.

Chapters cover the history of ichthyology in Pennsylvania, the waterways of the commonwealth, the origin of the fish fauna, introduced fishes, conservation efforts, the study of fishes, basic anatomy, characters and methodology for identification, collection techniques, photography, videography, and sport fishing opportunities.

The lavishly illustrated, 556-page hardcover tome likely will serve as the definitive reference on Pennsylvania fishes for many years to come. Featuring 575 color photos and 196 detailed maps, all printed on heavy, glossy stock, this handsome volume has the look, heft, and feel of a coffee table book. But due to its comprehensive and historic nature, it undoubtedly will serve as a textbook, too.

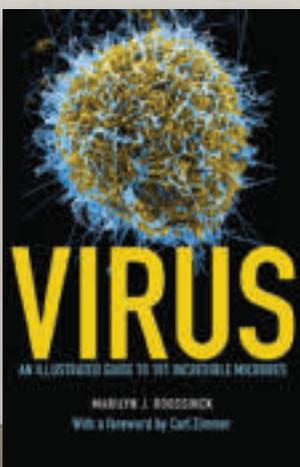
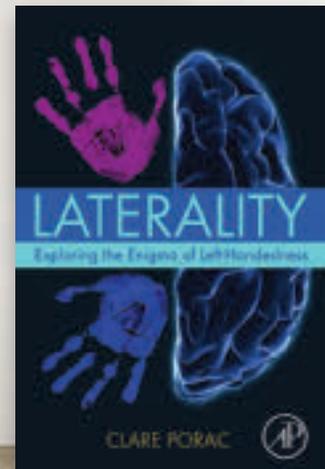
### LATERALITY: Exploring the Enigma of Left-Handedness

by Clare Porac, professor of psychology, Penn State Behrend

Left-handedness has been connected to many different conditions, traits, and abilities. This is especially true for pathological syndromes, such as schizophrenia, along with learning disabilities and autism, but left-handedness has also been linked to creativity, and to advantages in many sports, including tennis, fencing, and baseball.

How strong is the evidence for these commonly held beliefs? The published research on handedness is vast and contradictory, often raising more questions than it answers.

In *Laterality: Exploring the Enigma of Left-Handedness*, psychologist Clare Porac examines work in the field over the past 50 years and translates it into an accessible and readable form. Chapters cover the genetic and biological origins of handedness, familial and hormonal influences, the impacts of handedness on health and longevity, and the effects of a majority right-handed world on the behaviors of left-handers. In addition to summarizing the research, the book includes illustrative interviews with left-handers.

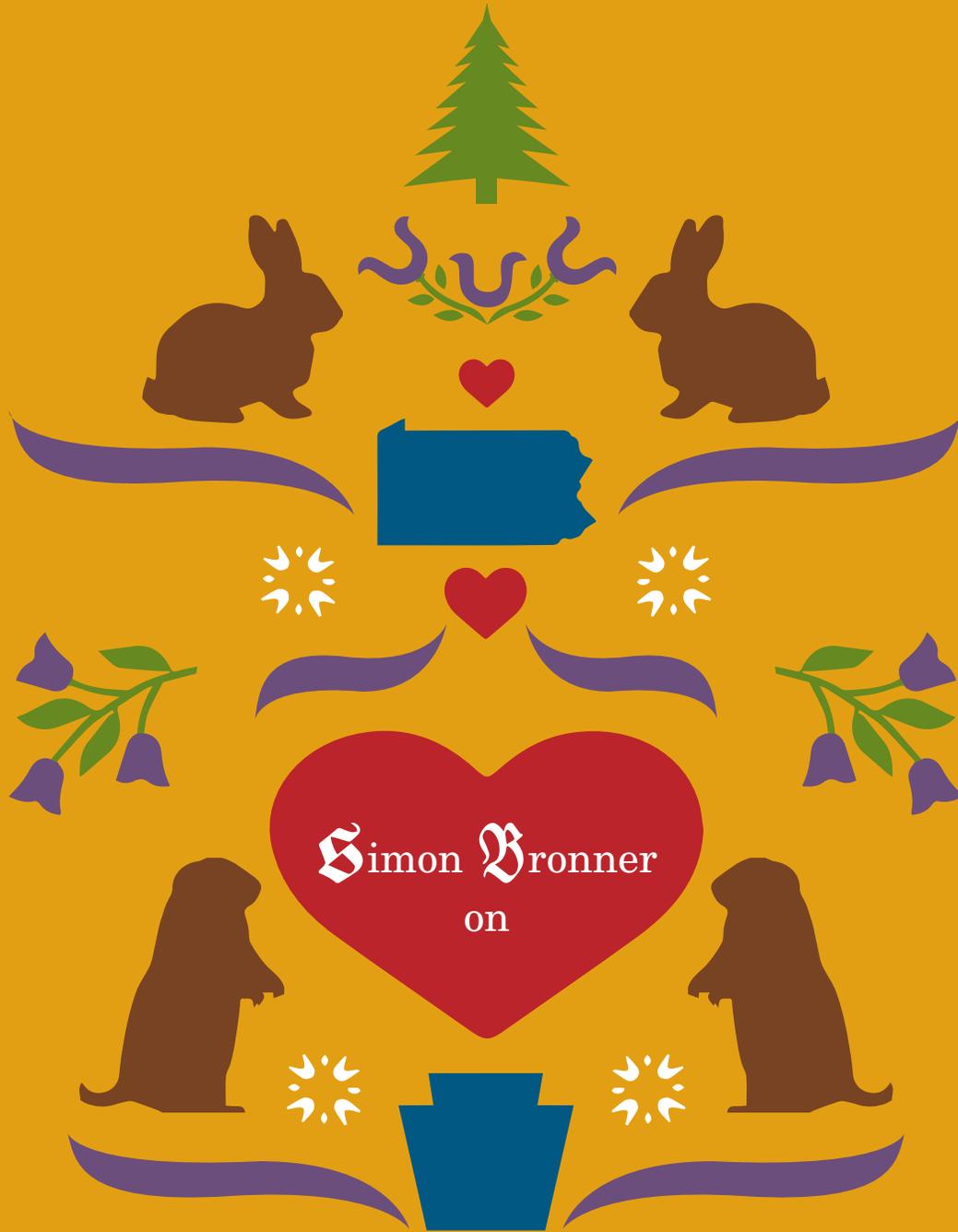


### VIRUS: An Illustrated Guide to 101 Incredible Microbes

by Marilyn Roossinck, professor of plant pathology and environmental microbiology

In *Virus: An Illustrated Guide to 101 Incredible Microbes*, Marilyn Roossinck provides a rare window into the amazing, varied, and often beautiful world of viruses—those that benefit their hosts as well as those that cause deadly illness.

Featuring hundreds of breathtaking colorized electron micrographs, this guide includes lively accounts of the history of virology, how viruses are named, how their genes work, how they copy and package themselves, how they interact with their hosts, how immune systems counteract viruses, and how viruses travel from host to host and spread from region to region. It features many viruses that threaten human health, such as dengue, Ebola, and Zika; and less well-known viruses such as the Tulip breaking virus, which produces the streaked colors of some varieties of tulip.



# Pennsylvania German Culture





**Pennsylvania Germans, who were among the earliest American settlers, still abide as an American folk group. Folklorist and historian Simon Bronner recently spoke with Cherie Winner about his new book, *Pennsylvania Germans: An Interpretive Encyclopedia*, and about current directions in the study of this distinctive culture.**

**WHY BRING OUT THIS BOOK NOW?**

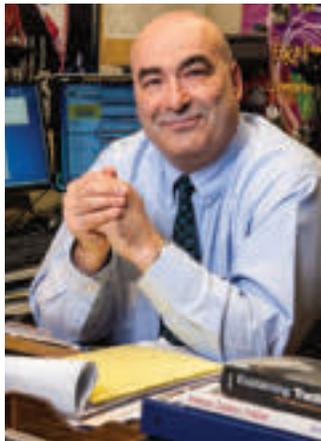
I was astonished to find that the last academic survey of Pennsylvania German history and culture came out almost 75 years ago. And why should they demand encyclopedic attention? The Pennsylvania Germans are a very old and extensive group—during the 18th century, it was estimated that one out of every three settlers in Pennsylvania spoke German or came from Germany—but they’ve often been dismissed because of the view that they’re not a contemporary group, outside of the Amish. We’re trying to show that many people maintain that heritage and find it significant to their identity.

**WHAT MAKES THE PENNSYLVANIA GERMANS A “FOLK GROUP,” AND HOW IS THAT DIFFERENT FROM AN ETHNIC MINORITY?**

Previously they were known as a folk group partly because of their association with the land and living closely in community. Today, you don’t have to be tradition-centered to be considered a folk group. The point is that you have traditions that you continue to express and use to maintain your identity. With an ethnic minority, you’re identified by your national ancestry whether or not you continue to have traditions that you maintain. Probably the best example is the Scots-Irish. They were also a colonial-era folk group, but they didn’t maintain community and their traditions in the same way that other groups did.

**THE PENNSYLVANIA GERMANS HAVE ALSO HAD A LARGE IMPACT ON THE DOMINANT CULTURE.**

Yes! Pennsylvania Germans are associated with the Christmas tree, the Easter bunny, funnel cakes, scrapple, and with Groundhog Day—the groundhog is the avatar of Pennsylvania Germans. In the Popular Culture chapter I document ‘groundhog clubs’ as far west as California, that get together and try to maintain their ‘Dutchiness.’



Joe Mattivi

**TELL US A LITTLE ABOUT THE “PENNSYLVANIA DUTCH” LANGUAGE.**

This is really an amazing story of a language that is distinctively an American dialect lasting for over 200 years. It is an amalgamation of many dialects in Germany, with a lot of English thrown in. The secular language is in decline, because it’s not a workaday language for many, but Amish and other Plain groups still use Pennsylvania German in their work and in their education.

**HOW HEALTHY IS THE CULTURE TODAY?**

Despite the decline in the language, we’re seeing a spread of Pennsylvania German cultural practices. Since the late 20th century, the Amish, for example, have expanded to over 30 states and provinces of Canada—Montana, Wyoming, Maine, Nova Scotia—places you would not expect. They actually sent out groups to search for where there was land and where they could set up schools and trades, because they believe in being close to one another in face-to-face communities. These new communities are essentially colonies of Pennsylvania.

**HOW HAS PENN STATE CONTRIBUTED TO STUDY OF THIS GROUP?**

Some of the first courses on Pennsylvania Germans came out of Penn State, and Pattee Library has several special collections that I’ve consulted for this book and other work. At the Center for Pennsylvania Culture Studies at Penn State Harrisburg, we continue to try to document these cultural features.

There’s a tendency to always look beyond your own back yard. Maybe because I am not originally from Pennsylvania, I saw all kinds of cultural riches and questions here, and I said, it’s several lifetimes of work just to document all the groups and cultural traditions that are here. Penn State of all places should do that, because of its land-grant mission, and I feel fortunate we’ve had support administratively and from the communities for doing that.

*Simon Bronner is Distinguished Professor of American Studies and Folklore and founding director of the Center for Pennsylvania Culture Studies at Penn State Harrisburg. His book, co-edited with Joshua Brown of the University of Wisconsin-Eau Claire, was published in February by Johns Hopkins University Press.*



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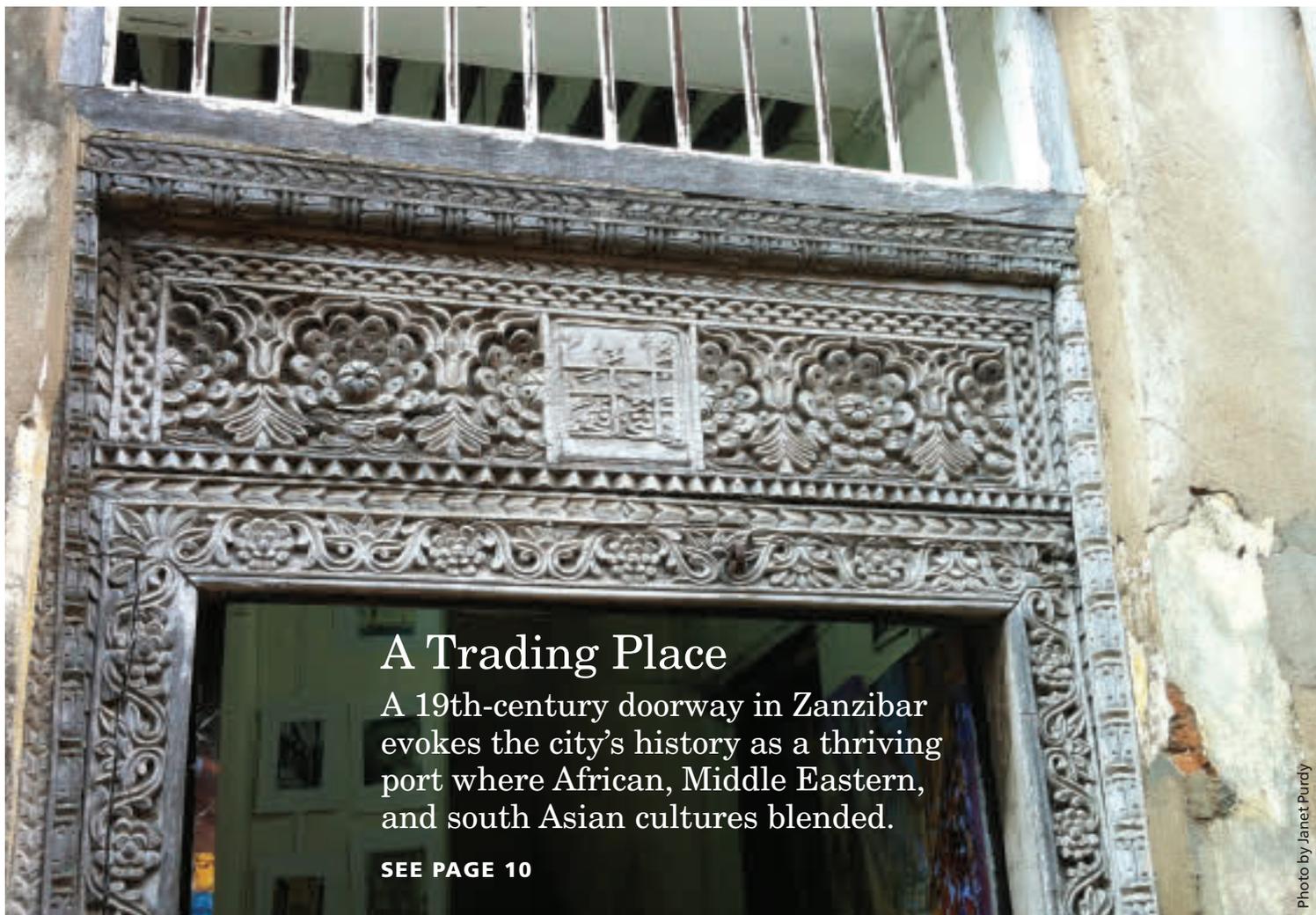


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## A Trading Place

A 19th-century doorway in Zanzibar evokes the city's history as a thriving port where African, Middle Eastern, and south Asian cultures blended.

**SEE PAGE 10**