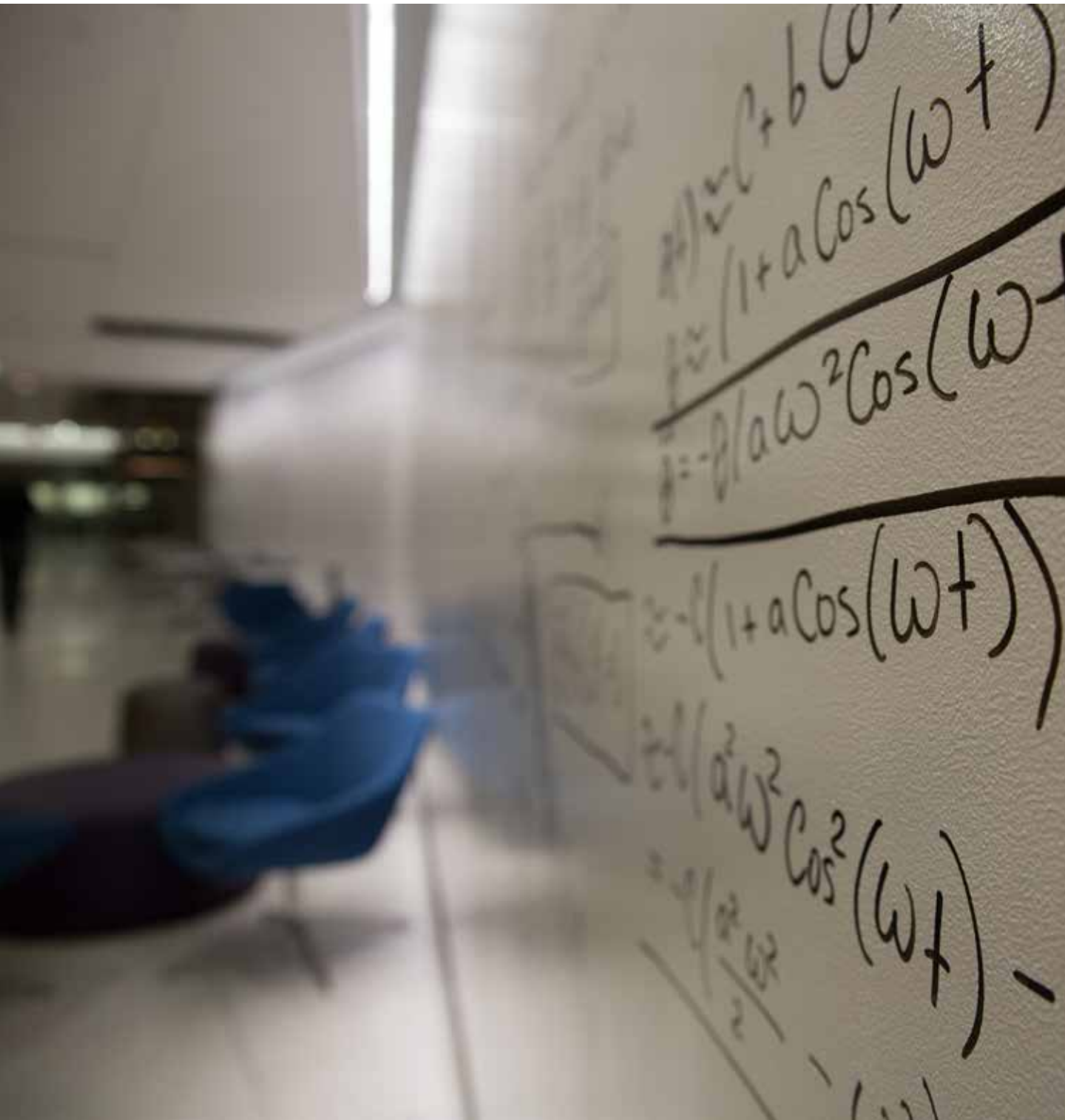
GW RESEARCH

THE GEORGE WASHINGTON UNIVERSITY
SPRING 2015



A BUILDING IN BLOOM

This winter, down the street from my office, research changed the shape of the nation's capital.

Rising from the former site of a parking garage now stands a half-million-square-foot home of research and discovery, newly populated with a range of expertise that spans from aerospace engineering to chemistry, biology to computer science and well beyond. It's a glass-walled think tank that alters not just the skyline but even the scene from the street, where windows look in on research in progress and hands-on learning.

That's just the physical change, to say nothing of the new Science and Engineering Hall's potential to impact health, infrastructure, defense and more in Washington, D.C., the nation and around the globe. As now-Board of Trustees Chair Nelson Carbonell said at the building's groundbreaking in 2011: "GW scientists and engineers can do a lot with a little. But just imagine what we can do with a lot."

Over the years, Science and Engineering Hall has come to symbolize research ambition here at GW. As the building took shape, the university's research profile reached upward along with it.

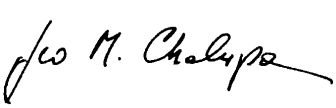
Despite what might have been the most challenging environment in decades for securing funding from the federal government and other entities, GW grew. In fiscal year 2013, research expenditures from external sources—a key measure of research activity—grew by more than 7 percent over the previous year; in 2014, they shot up by nearly 11 percent.

Student research, too, is on the rise. Nearly 500 students of various levels, and from clear across the academic expanse, presented posters during the 20th annual Research Days event this spring. That's a 12 percent increase over last year.

All of this, in no small part, is thanks to our tremendous faculty members, including the newer faces among them who came to GW on the promise—and the commitment—they saw in Science and Engineering Hall. Current and prospective graduate students and undergraduates are seeing the same thing, sensing the same momentum.

And that effect, I believe, is only just beginning.

Sincerely,



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FEATURES

DEPARTMENTS

Front cover: At workspaces and common areas in Science and Engineering Hall, equations spill over from desks onto surrounding dry-erase-marker friendly walls.
(Photo by William Atkins)

Back cover: A glassware tableau on a rack inside a chemistry lab (Composite photo by Zach Marin)

ANTHROPOLOGY

FOR MALE CHIMPS, A JUMP START ON SOCIALIZING THAT MAY BE KEY

Analysis of 37 years of data finds sons get extra exposure to adult males, chimps beyond immediate family, which may aid development of gender-specific social skills

Baby male chimps have more mingling opportunities than their female peers and these early social interactions may influence their temperaments later in life, according to new research.

Analyzing 37 years of data on chimpanzees in Tanzania's Gombe National Park, a GW-led research team found that mothers with sons were more social than those with daughters, particularly during early infancy. Scientists say this enables the sons to observe and absorb social behaviors such as grooming, aggression and mating.

The results were published in November in the *Proceedings of the National Academy of Sciences.*

"It's been known for a long time that there are sex differences in adult chimpanzee behaviors. Males are more gregarious, they form stronger social bonds with each other and they are more physically aggressive," says GW anthropology professor and lead author of the study Carson Murray, who is affiliated with GW's Center for the Advanced Study of Human Paleobiology. "We wanted to understand when and how these sex differences develop and to what extent mothers influence those differences."

Chimpanzees, like humans, form temporary social subgroups within their larger communities throughout the day. Since infant chimps are dependent on their mothers for at least five years, social interactions are restricted to those individuals with whom the mother spends time. So the researchers investigated differences in mothers' subgrouping patterns based on the sex of infants.

They hypothesized that mothers with sons would socialize more, since male offspring would need to rely more on social skills and bonds to integrate into the adult male hierarchy. Forming strong social bonds is less important for adult females, which spend most of their time caring for dependent children.

The data from Gombe National Park used in the study dates to celebrated primatologist Jane Goodall's

research from the 1970s.

"There have been other studies on infant chimpanzees, but the depth of information that the Gombe data set provides allows us to ask more detailed questions than ever before," says Maggie Stanton, a postdoctoral scientist at CASHP. "We could look within individual mothers to examine if and how their behavior changes in different circumstances, so we could compare how the same mother behaved with her sons versus with her daughters."

They found that mothers with sons spent an average of two hours more per day with chimps beyond immediate family members—25 percent more social time than mothers with daughters.

Additionally, mothers with sons spent more time around adult males during the infant's first six months than those with daughters, which suggests that having the opportunity to observe adult models may facilitate development of social skills important for success as an adult male.

In future studies, Dr. Stanton and the research team hope to investigate that outcome—whether males that have more social exposure as infants are more successful as adults.

—Lauren Ingeno

BUSINESS

AFTER NFL, MANY PLAYERS FACE BANKRUPTCY

A new study of bankruptcy rates among NFL players finds that many are going broke in retirement, and the problem may be a lack of financial planning.

In the report, released in April by the National Bureau of Economic Research, GW financial literacy expert Annamaria Lusardi and researchers at the California Institute of Technology and the University of Washington used court records, news reports and other public documents to track 2,016 players drafted by NFL teams from 1996 to 2003. Nearly 2 percent were bankrupt within two years of retirement. Fifteen percent had filed for bankruptcy within 12 years of playing their final NFL game.

"The reality is these people have earned enough to not have to work for the rest of their lives," says Dr. Lusardi, the Denit Trust Chair of Economics and Accountancy at the School of Business. "But they go bankrupt. And they don't go bankrupt 20 years down the road. It happens right away."

The traditional lifecycle model of salary and savings—a gradual increase in income over decades, coupled with long-term planning—is put to an extreme test, she says, when workers earn a large amount of their lifetime income in a short burst and at a young age.

The median earnings of the players in the report was $3.2 million (in 2000 dollars) and the average length of an NFL career is six years for a player who makes a club's opening-day roster, according to the league.

Length of career and total earnings aren't predictive of when, or how frequently, players will go bankrupt, the researchers found.

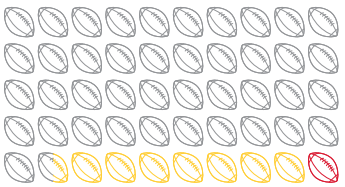
"That's quite striking, and I think this kind of hints at this lack of financial sophistication," Dr. Lusardi says. "The players who have long careers and higher incomes are the ones we don't expect to go bankrupt. But they do, and they do at the same rate as the others. That's an indication that the planning is not there."

Where the money goes depends on the player. But bad real estate or entrepreneurial investments are common catalysts for financial problems among ex-athletes, she says.

For that group, she says, "that next stage of life is very long and so managing money is a more complex decision. They don't realize it's enough for a lifetime if it's properly managed." *—James Irwin*

A STUDY OF 2,016 NFL PLAYERS DRAFTED BETWEEN 1996–2003 REVEALED ...

The percentage of players who declared bankruptcy after retirement, within two years and within six years:



- **2%** within two years
- **15%** within six years

The median earnings of players in the report period (in 2000 dollars):

$3.2 MILLION

The average length of an NFL career:

YEARS

SpaceX's Falcon 9 rocket and Dragon resupply ship lift off on the morning of Jan. 10 from Cape Canaveral, Fla.

SPACE

EXPERIMENT REACHES INT'L SPACE STATION

A science project designed by a four-student team from GW and Georgetown University finally reached the International Space Station in January, riding aboard a SpaceX rocket and resupply ship that carried groceries, belated Christmas presents and other experiments.

Shayda Shahbazi and Xixi Ni, both seniors in GW's School of Engineering and Applied Science, saw their original experiment perish in October, when the unmanned rocket transporting it exploded.

The project will assess the effects of microgravity on the germination of chrysanthemum seeds. Previous research has shown that the plant can purify and remove toxins from the air. If they are able to reproduce in space, chrysanthemums could one day serve as air purifiers on long-term missions.

"Working through numerous setbacks made the success that much sweeter," Ms. Shahbazi says. "I'm eager to begin the next phase of the project when the mini-lab returns to Earth."

If the space-bound seeds do germinate, the students will plant them on Earth for comparison with chrysanthemums grown from seeds that germinated here.

The students designed the experiment as part of their participation in the D.C. Space Grant Consortium Program. Their proposal was among 18 selected for flight in a competition that drew more than 1,400 submissions.

—Lauren Ingeno

CHEMISTRY

A RACE TO THE NORTH

As Alaskan permafrost rapidly melts, professor J. Houston Miller and his students are designing new technology for a trip to the ground zero of global warming

Summer in Fairbanks, Alaska, is far from the frozen landscape many imagine. The sun shines almost around the clock, the trees and grass are green and vacationers worry more about swarms of mosquitoes than blocks of ice. But amid the area's thick spruce forests and layers of moss is a region scientists are calling a climate time bomb.

"This is the center of climate change," says chemistry professor J. Houston Miller. "It's where everyone in the climate community is turning their attention."

That's because just below the mossy surface lies a layer of frozen earth known as permafrost. And while some of this icy rock, soil and peat has persisted for more than 10,000 years—since the last Ice Age—it is now melting rapidly. The thawing permafrost is releasing massive amounts of greenhouse gases into the air and, climate scientists contend, exacerbating global warming.

"Most people are aware of rising sea levels and temperature changes, but they don't know about permafrost," Dr. Miller says. "This is the big one. This is the one that really counts."

In June, Dr. Miller and a pair of graduate students will travel to the Alaskan hot spot on a mission to measure the effects of permafrost thaw. Their work is part

NASA/JIM GROSSMAN

of a multifaceted project funded by a $980,000 grant from NASA's Terrestrial Hydrology Program. Other research partners include the NASA Goddard Space Flight Center and the University of Alaska, Fairbanks.

Dr. Miller's role is to take ground-level measurements of greenhouse gas concentrations during the summer melting season, using a tool he is devising that will perform open-path, laser absorption measurements of damaging gas levels.

From the Fairbanks field site, he hopes to collect ultra-precise measurements that can validate NASA's satellite readings. It's the first step in defining a longterm measurement strategy and establishing a protocol for permafrost-related climate modeling.

A BROKEN CYCLE

Permafrost is known as a "carbon-sink," its rich soil storing organic material from decaying plants and animals. There may be as much as 1,000 billion metric tons of carbon in the permafrost ground, more than double the amount currently in the atmosphere.

Permafrost can be up to 5,000 feet thick, but it is the top "active" layer, which is just 1 to 3 feet deep, that most concerns climate watchers. The top layer thaws and refreezes each year. During the melting season, carbon—mostly in the form of carbon dioxide and particularly damaging methane—is released into the air.

But that thaw-and-refreeze cycle is being thrown off balance, Dr. Miller says. Alaska's temperatures are rising twice as fast as the rest of North America's. Ground temperatures in Fairbanks now hover near the thaw point, resulting in more rapid permafrost melt and more greenhouse gases spewed into the atmosphere.

Most permafrost models rely on satellite projections that, while remarkably detailed, also present limitations due to cloud cover, timing and distance. Dr. Miller's ground-level measurements should provide readings that complement NASA's satellite shots.

In Alaska, melting permafrost can cause trees to list or fall.

"Our measurements on their own won't be worth very much," he says. "The value will be in validating the satellite measurements, and creating a clear and consistent model."

Dr. Miller's latest prototype may not look like much. His laser is mounted atop a store-bought telescope tripod and attached to, as he calls it, a "spaghetti mess" of optical fibers, wires and electrical components. But he's confident that the final product will mark the first step in correlating vital climate data. And after the team returns to campus in July, he anticipates further refining his instruments for future Arctic excursions.

In the meantime, as Dr. Miller and his students rush to finish and test the instruments on a compressed timeline, they are also preparing for the realities of fieldwork in Alaska.

"We have to anticipate everything we could possibly need when we are out in the field," he says. "If a moose knocks over our laser in the middle of a spruce forest, we can't run to Loews for replacement parts."

—John DiConsiglio

ENGINEERING

BIOMEDICAL ENGINEERING COMES OF AGE

New department, PhD program are launched with renowned heart researcher at the helm

When asked by a prospective student's parent whether biomedical engineering was simply a "fad," Jason Zara, an associate professor who helped develop GW's undergraduate program on the subject more than a decade ago, was pointed in his response: "Well, do you want to die any time soon?"

Better health and a desire to live longer, he said, are never going out of style.

Recognizing the rapid growth of the field—outside the university and within, where it is one of the most popular engineering majors—the School of Engineering and Applied Science last fall launched a Department of Biomedical Engineering, along with a PhD program that joins existing ones for master's and bachelor's degrees. The move carved out a distinctive home for biomedical engineering, formerly

part of the Department of Electrical and Computer Engineering, at a pivotal moment: The engineering school this spring took up residency in GW's long-awaited interdisciplinary research hub, Science and Engineering Hall.

"For all of you who waited such a long, long time for this day, for the creation of this new department, we are finally there," SEAS Dean David Dolling told more than 150 engineering students, faculty and alumni who gathered in January to mark the department's official beginning in the new building.

Heart researcher Igor Efimov arrived at GW that month from Washington University in St. Louis to lead the new endeavor. Dr. Efimov, the Alisann and Terry Collins Professor of Biomedical Engineering, currently focuses on new therapies to treat patients with abnormal heart rhythms, such as an implantable device that wraps around the heart to detect impending cardiac arrest.

Traditional defibrillators can deliver up to 1,000 volts of electricity to the heart, which can lead to long-term damage. Dr. Efimov's device applies 100 times less energy to knock the heart back into rhythm. A network of sensors sends signals to a smartphone, which gives doctors real-time data on the heart's functions. The device also provides a high-definition view of the heart, resulting in more precise, accurate disease monitoring.

Dr. Efimov's long-term plans for the department include hiring 10 new faculty members by 2020 and using the university's unique proximity to federal research powerhouses—like the Food and Drug Administration, the National Science Foundation and the National Institutes of Health—to create graduate and PhD programs in biomedical regulatory affairs.

"In the past our PhD pathway had only one goal: to train future professors. Any other trajectory was not considered appropriate," Dr. Efimov says. "Now we really have to consider that our PhD students have many different professions to consider."

—Lauren Ingeno

URBAN STUDIES

SETTING THE PACE FOR WALKABILITY

The D.C. metropolitan region has been ranked the most walkable urban metro area in the nation, according to a report released last June by GW's Center for Real Estate and Urban Analysis, in conjunction with LOCUS, an advocacy coalition of Smart Growth America.

"There is a structural shift occurring in how real estate is developed in this country—from drivable suburban sprawl to walkable urbanism," says the center's chair, Christopher B. Leinberger, who led the research and serves as the Charles Bendit Distinguished Scholar at GW's School of Business. "We wanted to document that trend and provide concrete, market-based evidence that walkable urban places can generate extraordinary economic value."

The report ranked the nation's 30 largest metropolitan areas, assessing the number of walkable urban places in each and the percentages of office and retail space found there.

The D.C. area's top spot is due in part to its having the highest percentage of total office and retail space located within its walkable areas, the report found. And its walkable spaces were almost evenly split between the city and the suburbs.

By comparison, Mr. Leinberger says, "the vast majority of walkable urbanism in New York is on Manhattan, where 8 percent of the population lives in only 0.3 percent of the landmass of the region."

—Brittney Dunkins

		NUMBER OF WALKABLE URBAN PLACES	SHARE OF OFFICE AND RETAIL SPACE IN WALKABLE PLACES
1	**Washington, D.C.**	45	43%
2	**New York**	66	38%
3	**Boston**	37	36%
4	**San Francisco**	57	30%
5	**Chicago**	38	29%
6	**Seattle**	23	27%

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BIOLOGY

HOW AMPHIBIANS WENT GLOBAL

In a surprising finding, they may have swum great distances, in addition to the expected short swims and moves with and over land masses

With more than 7,000 known species, amphibians can be found on six of the seven continents and in nearly every type of ecosystem. But there have been few attempts to understand exactly when and how frogs, toads, salamanders and the wormlike caecilians spread across the planet over the past 300 million years.

In what's being called the first large-scale study of its kind, Alex Pyron, an assistant professor of biology, has pieced together the evolutionary and geographic journey of more than 3,000 amphibian species, including nearly half of all existing species from every taxonomic group.

"There have been smaller-scale studies, but they included only a few major lineages and were very broad," Dr. Pyron says. "What we needed was a large-scale phylogeny [or evolutionary tree] that included as many species as possible. That allows us to track back through time not only how different species are related but also how they moved from place to place."

Biologists have long hypothesized that the distribution of amphibians has been driven by two major processes: vicariance, in which a population is separated by a geophysical event, like the fragmentation of supercontinent Pangaea, and the other is dispersal, in which the population travels across land bridges or short distances across oceans.

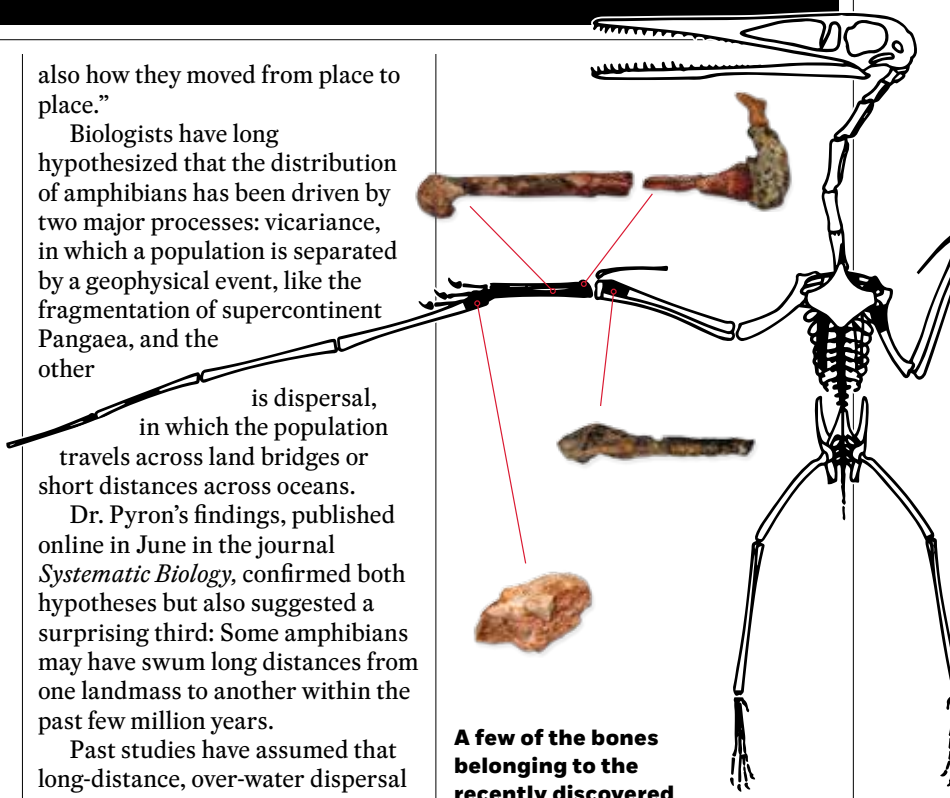
Dr. Pyron's findings, published online in June in the journal *Systematic Biology,* confirmed both hypotheses but also suggested a surprising third: Some amphibians may have swum long distances from one landmass to another within the past few million years.

Past studies have assumed that long-distance, over-water dispersal was essentially impossible for amphibians due to salt intolerance. However, when Dr. Pyron began completing his analysis, he noticed a number of cases that could not be explained by old age. For instance, one group of frogs found in Australia and New Guinea emerged long after the continental divide, but is deeply rooted within a group of amphibians that exists only in South America.

"You wouldn't think that frogs would be able to swim all the way there, but that seems like one of the more likely explanations," Dr. Pyron says. "They're 120 million years too late to have walked to Australia."

—Lauren Ingeno

FROG: ©ISTOCK.COM/ANTAGAIN / PTERODACTYL ILLUSTRATION: BRIAN ANDRES



A few of the bones belonging to the recently discovered *Kryptodrakon progenitor,* the earliest and most primitive pterodactyl

PALEONTOLOGY

OLDEST PTERODACTYL DISCOVERED

An international research team has discovered the earliest and most primitive pterodactyl—a group of flying reptiles that would go on to become the largest flying creatures ever known—and pushed back their emergence by 5 million years.

Working from a fossil discovered in northwest China, the team—led by University of South Florida paleontologist Brian Andres, MS '03, his then-mentor, James

Clark of GW's Columbian College of Arts and Sciences, and Xu Xing of the Chinese Academy of Sciences—named the new pterosaur species *Kryptodrakon progenitor*, from the Latin *krypto* (hidden) and *drakon* (serpent), a reference to the movie *Crouching Tiger, Hidden Dragon*, which was filmed near the place of the fossil's discovery.

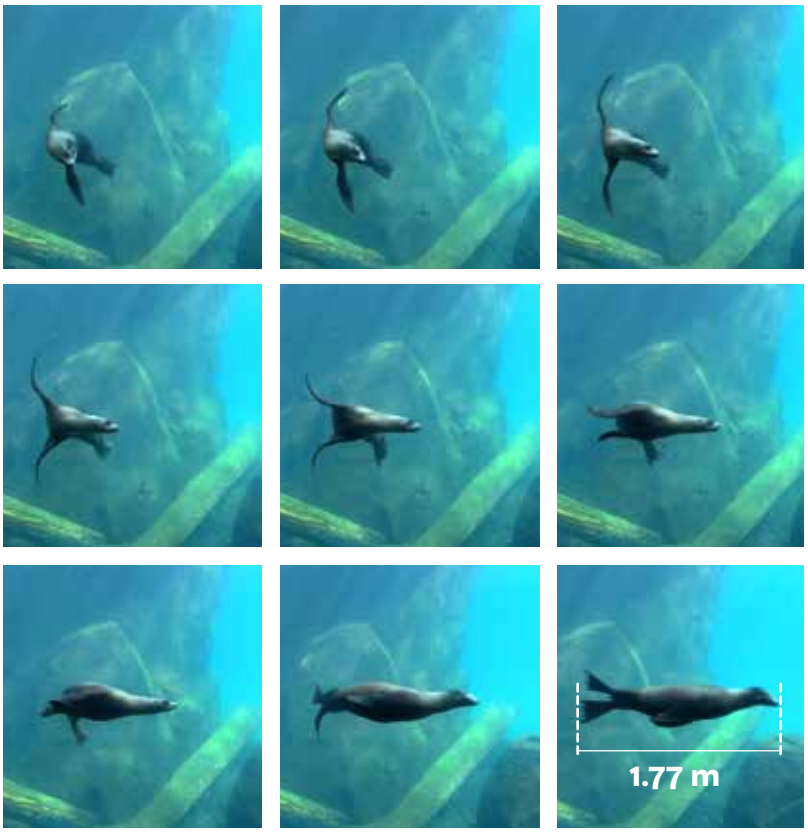
The team's analysis, published in April in the journal *Current Biology*, determined the fossil to be the first of the broad group called pterosaurs to bear the characteristics of the subgroup Pterodactyloidea, which would become the dominant winged creatures of the prehistoric world. The findings indicate that these reptiles flew above the Earth 163 million years ago.

Pterodactyls—which evolved into giant creatures, some as big as small planes—went extinct with the dinosaurs, about 66 million years ago. They are considered close relatives to the dinosaurs but are not dinosaurs themselves.

The small fossil is thought to have a wingspan of about four and a half feet. It was discovered in 2001 by Chris Sloan, formerly of National Geographic and now president of Science Visualization, in an area of northwest China known for its once-muddy pits that ensnared a range of prehistoric creatures. The discovery took place on an expedition led by Dr. Xu and Dr. Clark, when Dr. Andres was a graduate student at GW.

The discovery provides new information on the evolution of pterodactyloids, Dr. Andres says. As the pterosaurs evolved, their wings changed from being narrow and more useful in marine environments to being more broad and helpful in navigating land environments.

The new species "fills in a very important gap in the history of pterosaurs," Dr. Andres says. "With him, they could walk and fly in whole new ways."



A sea lion at rest moves into a full fore-flipper clap, then glides.

FLUID DYNAMICS

AMAZING GRACE

In sea lions, engineers search for mechanisms behind expert swimming

When Megan Leftwich took her children to the zoo two years ago to see the sea lions, which slipped through twists and flips like underwater ballerinas, it was Dr. Leftwich who came away with a head full of wonder.

"I just thought, 'Man, those are amazing swimmers.' I really wanted to study them," says Dr. Leftwich, a fluid dynamics researcher in the Department of Mechanical and Aerospace Engineering.

The marine mammals are not only lithe swimmers, they're also capable of reaching 25 miles per hour. And they move through water unlike any other animals on Earth.

While fish and other aquatic mammals thrust forward with their tails or caudal fins, sea lions rely on their fore flippers, which are analogous to human arms. They sweep downward, clap their large flippers into their bodies and glide forward, producing jet propulsion. Sea lions are able to cruise the length of an Olympic-size pool with a single clap.

Other animals that use jets to propel forward, like octopi and squid, cannot sustain high speeds or manipulate their bodies with the same agility. Sea lions also produce a barely traceable wake in the water, differing significantly from other swimming mammals.

"I want to know, what is

COURTESY LEFTWICH LAB

THE MARINE MAMMALS ARE NOT ONLY LITHE AND SPEEDY SWIMMERS, THEY MOVE THROUGH WATER UNLIKE ANY OTHER ANIMAL.

the paradigm for successful swimming?" Dr. Leftwich says.

To find out the science behind the sea lions' swimming mechanisms, Dr. Leftwich returned to the Smithsonian's National Zoo. As part of an ongoing research partnership, her team visits California sea lions and uses high-definition video cameras to digitize the unique motions of their flippers.

After analyzing the videos, Dr. Leftwich and post-doctoral scientist Chen Friedman compare differences in the sea lions' claps and body maneuvers in order to highlight correlations in features such as angular velocity and flipper curvature.

Observing zoo animals does, however, come with limitations: It does not allow the researchers to analyze how the flipper affects the movement of the water. To compensate for that, students and researchers in Dr. Leftwich's lab are working on a robotic flipper that mimics the sea lions' motion. Once complete, they will send it through a lab-length water tunnel and chart the water's movement, as well as the forces it takes for a sea lion to move its knuckles, wrists and elbows. (Sea lions' front flippers have all the skeletal elements of land mammals.)

When one of the zoo's sea lions died last year, Dr. Leftwich's lab obtained her flipper. Josh Waldron, one of six undergraduates working in Dr. Leftwich lab, spent the summer taking high-resolution images of the flipper's skin samples at the micro-scale, using a high-powered scanning electron microscope.

"One really interesting thing we found when we looked at the images is that different parts of the flipper have varying amounts of fur and smoothness," says Mr. Waldron, a junior studying mechanical and aerospace engineering. "We want to try and uncover how the sea lion's hair and skin play a role in its hydrodynamics to give it such an advantage when it does turns in water."

To help Mr. Waldron prepare to image the sea lion samples, he enlisted the help of researchers in engineering professor Grace Zhang's lab, where novel 3-D printing techniques are being used to create custom-designed tissue substitutes.

"Most people in the Mechanical and Aerospace Engineering Department don't handle sea lion tissue, oddly enough," he says. "So there was a lot of inter-departmental collaboration to help one undergraduate research student."

One potential application for better understanding these highly maneuverable, difficult-to-trace mammals is to inform the design of underwater vehicles, such the autonomous ones used by the Navy for disarming underwater bombs.

But Dr. Leftwich is hesitant to say that her research is confined to solutions for any one problem.

"I feel like if we don't know all of the potential applications, that's really a good thing," she says. "Often problems are solved by accident because of investigating some fundamental phenomenon in and of itself." *—Lauren Ingeno*

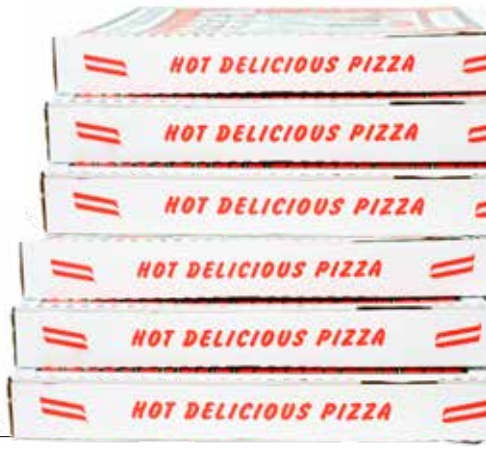
PUBLIC HEALTH

CHILDHOOD OBESITY: IS PIZZA THE PROBLEM?

Pizza consumption is associated with many of the same negative effects of fast food, including excess calories and increased sodium intake, and could be tipping youth toward obesity, according to a new study co-authored by a Milken Institute School of Public Health researcher.

The study, published in January in the journal *Pediatrics,* shows that one out of five U.S. children and nearly a quarter of adolescents consume pizza on any given day. The researchers found that on those days a child consumes an extra 84 calories, 3 grams of saturated fat and 134 milligrams of sodium. For teenagers, it's an excess 230 calories, 5 grams of saturated fat and 484 milligrams of sodium.

"What's not to like about pizza?" says Bill Dietz, director of GW's Sumner M. Redstone Global Center for Prevention and Wellness. "But



rather than being an everyday food, I think people need to recognize that this is a significant source of calories."

The researchers analyzed dietary data in the National Health and Nutrition Examination Survey, covering 2003 to 2010. Their findings were more or less consistent across gender, race/ethnicity and income.

The team found that in 2009-10, on days when pizza was eaten it represented 22 percent of children's total calories and 26 percent of teens' calories. And it had the greatest adverse impact for both groups when it was eaten as a snack, rather than a meal.

Despite the high numbers, the study showed that from the 2003-04 survey to the one in 2009-10, calories consumed from pizza declined by 25 percent among children. Daily average calories from pizza also declined among teens, but more teens reported eating pizza in this period.

While he acknowledges the positive trend, Dr. Dietz says the numbers suggest that pizza remains a significant contributor to childhood obesity.

According to one previous study, he says, the decrease in daily calories needed to return the mean Body Mass Index to a healthy total by year 2020 is around 150 calories per day for U.S. children age 6 to 11 and around 180 calories per day for teenagers.

"These apparently modest declines in pizza consumption could be significant contributors to the fact that we're seeing changes in the prevalence of obesity in the youngest children—because the caloric deficit is the smallest there—and why we're seeing plateaus in older children and teenagers," he says. "Our data suggests that changes in pizza consumption can have a positive impact."

—Lauren Ingeno

7

The number of Grammy-nominated projects that ethnomusicologist and adjunct professor Kip Lornell has worked on, including a 2015 nominee: the 255-page album notes for *The Rise and Fall of Paramount Records 1917-1932, Volume 1*. He won one of the little gilded gramophones—which he keeps perched over his fireplace—in 1997, as co-author of the notes for Smithsonian Folkways Recordings' *Anthology of American Folk Music*. ***—Julyssa Lopez***

> We have a dam that's protecting us from this flood of bacteria—and the dam is antibiotics. Each time one of these types of bacteria becomes resistant to all of those antibiotics, it's like water coming over the dam.

—Milken Institute School of Public Health epidemiologist **Lance Price** speaking about his research—pioneering the use of genetics to understand the creation and spread of superbugs—and the topic of the recent documentary *Resistance*, in which he's featured as an expert.

WWW

For more on this story, visit go.gwu.edu/resistancefilm.

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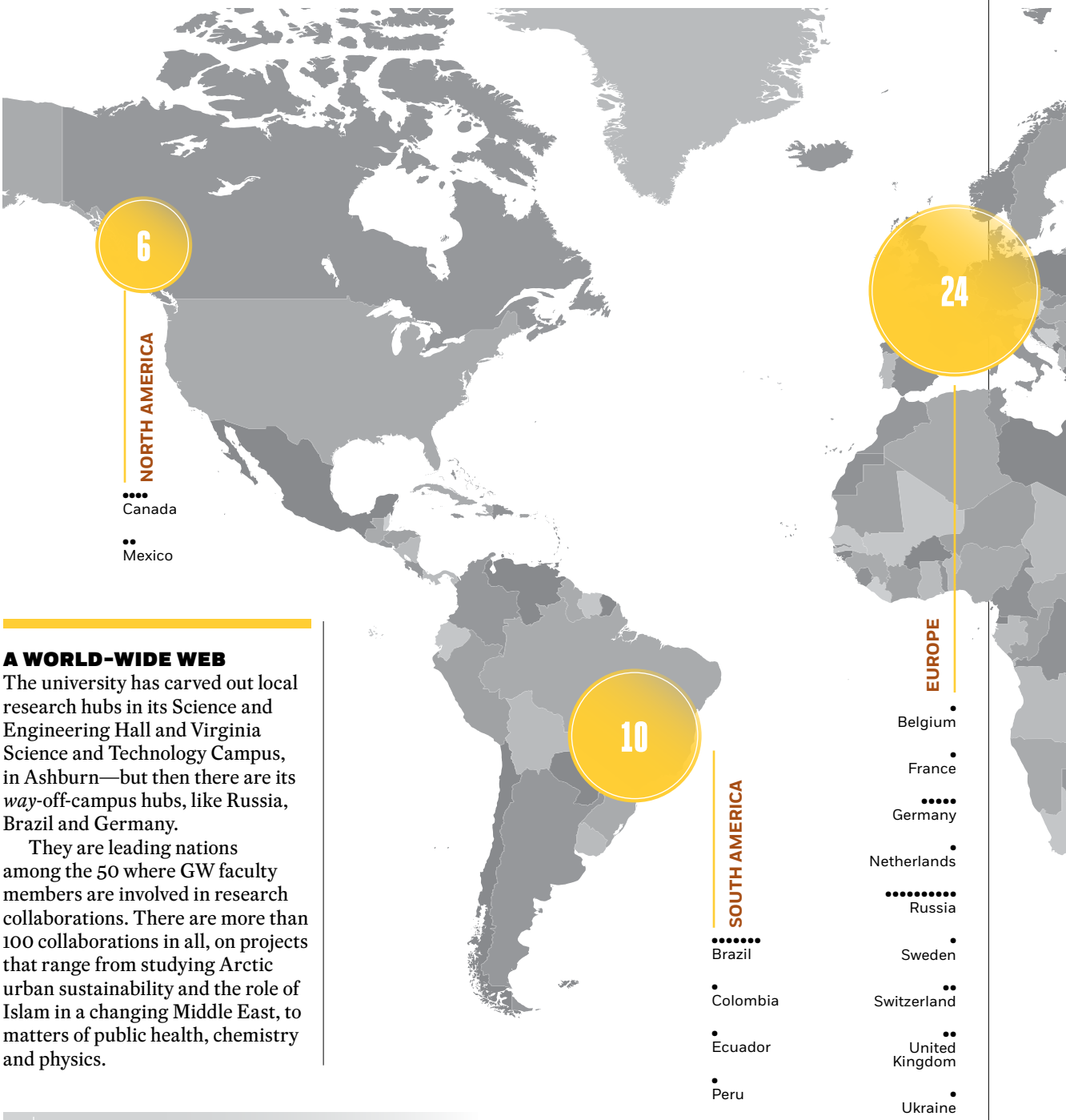


A WORLD-WIDE WEB

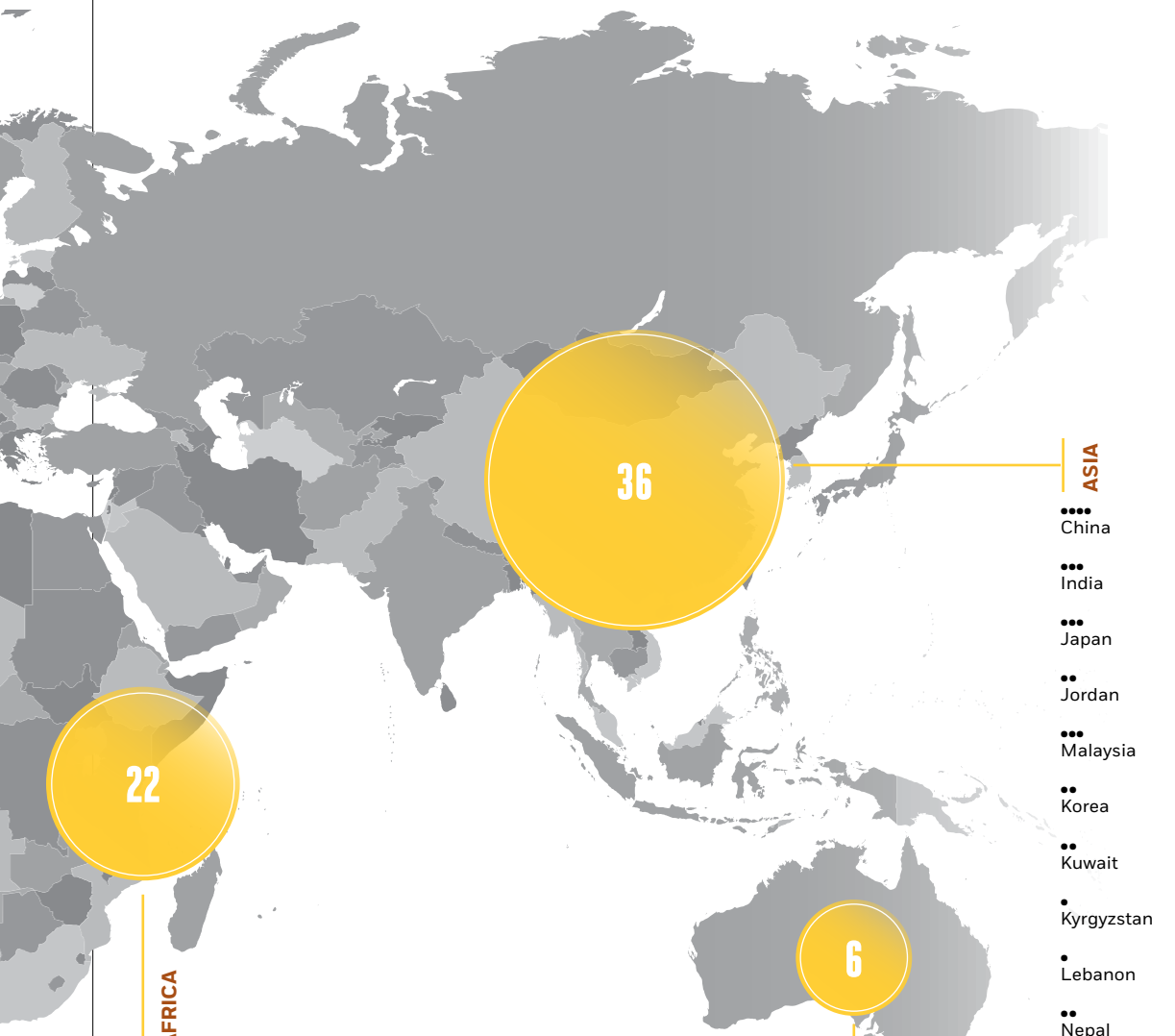
The university has carved out local research hubs in its Science and Engineering Hall and Virginia Science and Technology Campus, in Ashburn—but then there are its *way*-off-campus hubs, like Russia, Brazil and Germany.

They are leading nations among the 50 where GW faculty members are involved in research collaborations. There are more than 100 collaborations in all, on projects that range from studying Arctic urban sustainability and the role of Islam in a changing Middle East, to matters of public health, chemistry and physics.

KEY

The map shows the number of collaborations ...

6 per continent ••••• per country



ASIA

- China
- India
- Japan
- Jordan
- Malaysia
- Korea
- Kuwait
- Kyrgyzstan
- Lebanon
- Nepal
- Pakistan
- Saudi Arabia
- Thailand
- Turkey
- Vietnam
- Yemen

AFRICA

- Botswana
- Egypt
- Ethiopia
- Ghana
- Kenya
- Malawi
- Morocco
- Mozambique
- Nigeria
- Senegal
- South Africa
- Tanzania
- Tunisia
- Uganda
- Zambia
- Zimbabwe

AUSTRALIA/OCEANIA

- Australia
- Guam
- New Zealand

LAW

FAMILY COURT ON TRIAL

Study will test handling of custody cases involving abuse allegations

GW Professor of Clinical Law Joan S. Meier received a $500,000 grant last year from the National Institute of Justice to fund research into how family courts decide custody cases involving abuse allegations.

For the three-year study, Ms. Meier and her team will analyze around 2,000 state court custody cases from a 15-year period, looking at a spectrum of factors including the allegations of each party, the court findings and the custody or visitation order that was issued.

The study, she says, comes amid growing concern from domestic violence scholars and advocates that family courts are awarding unsupervised access or custody to abusive fathers.

The GW Law School professor is the founder of the Domestic Violence Legal Empowerment and Appeals Project, or DV LEAP, a nonprofit that provides free legal representation in domestic violence appeals. She says her organization and others receive numerous pleas from women who say that judges do not believe their claims of abuse and instead seek to maximize fathers' access to children. But relatively little data indicate how prevalent the problem is.

"Most people assume ... that courts are sympathetic to the mothers who complain of abuse. But in our experience, they're much more reluctant to believe abuse claims," Ms. Meier says.

Rather, she says, theories like parental alienation—in which a mother is making a safety claim merely to alienate children from their father—have had a large impact on family courts.

Results from a pilot study, in which Ms. Meier analyzed 240 custody opinions involving abuse allegations, indicated that mothers who alleged child sexual abuse lost primary custody 20 percent more often than mothers who did not allege abuse. The findings also showed that even when courts validated adult domestic violence allegations against fathers, the fathers received a custody outcome in their favor more than 40 percent of the time.

"I don't believe that these mothers are fabricating abuse, but I think the system thinks that they are," she says. "The numbers may provide powerful evidence that the system is too skeptical."

—Lauren Ingeno

INTERDISCIPLINARY

A LUMINOUS GLOW, RACING HEARTS

Optogenetics may offer insight into complex relationship of the body's "fight or flight" response and deadly arrhythmias

When you are anxious or sense danger approaching, your sympathetic nervous system kicks into gear and releases a neurotransmitter, called norepinephrine, from your neurons, triggering a "fight or flight" response in the body.

Your palms sweat. Your breath quickens. Your blood sugar skyrockets.

To increase blood flow to the muscles, sympathetic fibers also release norepinephrine in your heart. It throbs, faster and faster.

Usually, your heart rate will slow back to normal, but sometimes, all of that sympathetic activity can cause the heart to pump dangerously out of sync—or stop beating altogether.

"If you have an existing heart problem, a sudden increase in heart rate and force, motivated by the fight or flight response, can reveal it," says Matt Kay, an associate professor of biomedical engineering in the School of Engineering and Applied Science.

While there seems to be a clear link between irregular heartbeats, known as arrhythmias, and the body's response to severe stress, scientists still don't fully understand the complex relationship.

Now an interdisciplinary team of GW engineers and physiologists is taking a deeper look at this phenomenon using optogenetics, or the use of light to selectively manipulate neurons and physiological behavior in genetically altered animals.

"Our goal is to better understand the interaction between sympathetic neurons and heart tissue, and how it might lead to dangerous arrhythmias or sudden cardiac death," says Anastasia Wengrowski, a biomedical engineering doctoral student. "If you can better understand how, where and why the problem happens, then you can go about fixing it."

BLENDING BIOLOGY AND TECHNOLOGY

More than 325,000 people nationwide experienced sudden cardiac arrest outside of hospitals in 2011, according to a report released last year by the American Heart Association and the American Stroke Association. Nearly 90 percent of them died.

Unlike a heart attack, which often occurs when arteries in the

heart are blocked, cardiac arrest happens when there's a glitch in the heart's electrical system. Without immediate treatment, it's deadly.

Dr. Kay has spent years studying the "tornadoes" of electricity that twist in the heart's ventricles, a leading cause of sudden cardiac arrest. In his lab, researchers have assembled a system of tubing and pumps to keep alive the hearts of mice and rabbits. Using LED lights, high-speed cameras and a fluorescent dye that illuminates the heart's electrical activity, the team is able to image the activity and record data, such as changes in heart rate and waves of depolarization flowing through the heart.

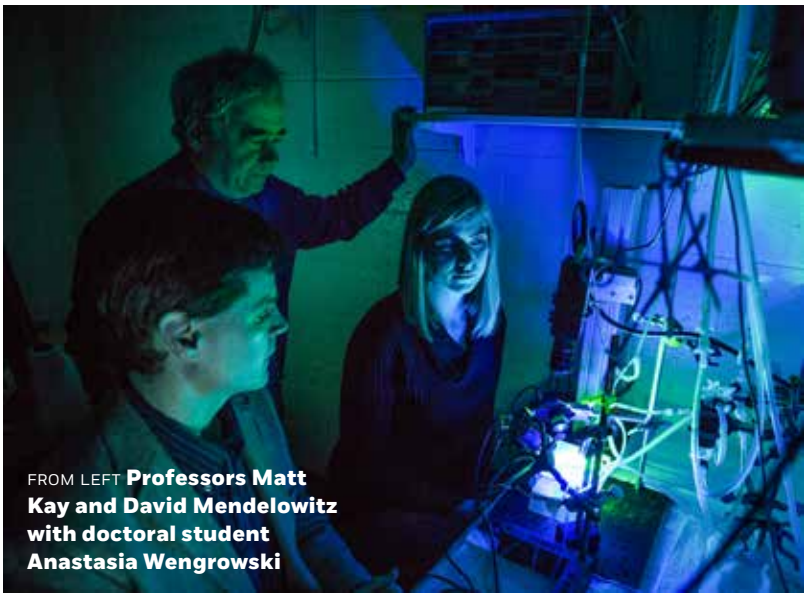
It was during a racquetball game with David Mendelowitz, a professor of pharmacology and physiology in the School of Medicine and Health Sciences, that he wondered whether there might be an overlap in their research. Dr. Mendelowitz studies how neurons in the brain control heart rate. His lab uses mice bred to express light-activated proteins to study the role of brain regions in cardiovascular diseases.

"We thought it would be interesting to study whether this model created a condition where we could use light to activate sympathetic response in the heart," Dr. Kay says.

PUMPING THE HEART—WITH LIGHT

The result is, essentially, a fight or flight response at the flip of a switch. When PhD student Ms. Wengrowski shines blue LED lights on the transgenic mouse hearts, the hearts' light-activated protein excites the sympathetic neurons, setting off the heart's response.

"It's a cutting-edge idea," Dr. Kay says. "Optogenetics has been developed in the past five years in the neuroscience field. But it has not been applied extensively in cardiology."



FROM LEFT **Professors Matt Kay and David Mendelowitz with doctoral student Anastasia Wengrowski**

Gathering data from the imaging system to detect changes in cardiac function, Ms. Wengrowski found that light caused the hearts to beat faster, contract more forcefully and made them more susceptible to arrhythmias. The results were published this winter in the journal *Cardiovascular Research.*

Methods used in the past don't allow researchers to study the heart's sympathetic activity in detail, Dr. Mendelowitz says, or they create the response with an artificial, widespread perfusion of hormones, rather than the natural nervous system mechanism.

"What is unique about our model is that the sympathetic neurons can be selectively activated with light, without activating anything else at the same time, which more closely mimics what happens physiologically."

Ms. Wengrowski says this new approach to studying the heart could lead to better-targeted drugs and medical treatment. Next, the researchers plan to potentially inhibit, rather than stimulate, sympathetic fibers to see how that may reduce the risk of arrhythmias.

—Lauren Ingeno

WILLIAM ATKINS

MEDICINE

NEW TREATMENT FOR SHOCK IDENTIFIED

License agreement signed and FDA bumps drug testing to phase III clinical trial

A GW doctor has discovered a new use for a drug that could mean the difference between life and death for thousands of emergency room patients each year.

In a 20-person clinical trial conducted at GW Hospital's Intensive Care Unit in 2014, professor Lakhmir Chawla and his team used angiotensin II, a peptide hormone, as a successful treatment for distributive shock—a life-threatening medical condition that occurs when a patient's blood pressure plummets.

When patients go into this type of shock, after a bacterial infection, allergic reaction or severe

accident, doctors attempt to raise their blood pressure using either catecholamines or vasopressin therapy. But some critically ill patients do not respond to these drugs, which, in high doses, can cause side effects, including permanent damage to the heart.

Angiotensin II has the potential to save these patients who do not respond to existing treatments.

"In 1940, if you had a headache, the only choice you had was aspirin. Twenty years later, you could take Tylenol. Now, you can take ibuprofen," says Dr. Chawla, an associate professor of anesthesiology and critical care medicine in the School of Medicine and Health Sciences. "I would argue that having a third option is a big deal. People have different issues with different drugs."

In addition, catecholamines, vasopressin and angiotensin are natural peptides produced by the human body that all work together to increase blood pressure. Dr. Chawla hopes that using these drugs together will improve their effectiveness and reduce the overall toxicity of any one treatment.

Following the clinical trial at GW, the U.S. Food and Drug Administration gave approval for the researchers to bypass phase II testing and move into phase III, which could cut years from the time it will take to market the drug.

Now, GW has entered into a license agreement with California-based La Jolla Pharmaceutical for GW intellectual property rights covering the use of angiotensin II to treat patients with hypotension and shock. In the phase III clinical trial, La Jolla will test the drug on 300 patients at up to 40 U.S. hospitals to confirm its effectiveness and monitor side effects.

"It is extremely rare that you would have a pharmaceutical come out of a university and go straight into a phase III clinical trial," says Steve Kubisen, director of GW's Office of Technology Transfer.

And unlike a drug for say, cancer, angiotensin II begins working almost immediately, Dr. Chawla says, which means doctors could quickly examine its effectiveness and side effects.

Vice President for Research Leo Chalupa says he is "cautiously optimistic" that the drug soon will be available in hospitals, noting that roadblocks could arise between phase III clinical trials and manufacturing. If the drug is marketed, Dr. Chalupa says, he believes it will be a "tipping point" for the university.

"Not only would it bring in substantial income to the inventor, university and the school, but it would also be a tremendous boost to other faculty who may realize that they, too, have invented something with commercial potential," he says. "Success breeds success."

Dr. Chawla hopes that, in addition to treating hypotension, the phase III clinical trials will show that the drug improves survival rates for patients. But that is often difficult to prove in a clinical study.

"We know that many of the supportive therapies that we use in medicine are important, but it is very hard to directly attribute them to a mortality benefit," he says. "Our primary goal is to demonstrate that angiotensin II is safe and can give clinicians another tool in the toolbox. If it improves survival, that's a grand slam."

—Lauren Ingeno

NEW FACES

ALLISON MACFARLANE: The former chair of the U.S. Nuclear Regulatory Commission joined the Elliott School of International Affairs this year as director of the Center for International Science and Technology Policy and the related Master of Arts program. Dr. Macfarlane, who studies nuclear waste issues, led the commission from July 2012 to December 2014.

CHRYSSA KOUVELIOTOU: The scholar of gamma-ray bursts, the most powerful explosions in the universe, has joined the Physics Department from NASA's Marshall Space Flight Center. A member of the National Academy of Sciences, she was among *Time* magazine's 25 most influential people in space in 2012.

CHRISTOPHER ROLLSTON: Among the leading translators of ancient Near East inscriptions, Dr. Rollston came to GW last year as an associate professor of Northwest Semitic languages and literatures. A master of more than a dozen dead languages, he served as a visiting professor at GW in 2013.

SABINA ALKIRE: The economist comes to the Elliott School after leading Oxford University's Poverty and Human Development Initiative. In 2010, she was named one of *Foreign Policy*'s "Top 100 Global Thinkers" for her work with an Oxford colleague and GW's James Foster on creating the Multidimensional Poverty Index, which is used by the United Nations.

MACFARLANE: NUCLEAR REGULATORY COMMISSION / KOUVELIOTOU: NASA/MSFC / ROLLSTON: MARNE TAYLOR / ALKIRE: COURTESY SABINA ALKIRE

PUBLIC HEALTH

CADMIUM LINKED TO AGING, DISEASE

Exposure to cadmium, even at low levels, may put people at significantly higher risk for diseases associated with aging, according to a new study from a GW researcher.

Ami Zota, a professor in the Milken Institute School of Public Health, and her colleagues found that the heavy metal is associated with the shortening of telomeres, DNA protein complexes that cap the end of chromosomes and protect them from deterioration.

Telomere shortening is a normal part of getting older, Dr. Zota says, but cadmium exposure seems to speed up the process.

Cadmium is released into the environment from mining and metal processing operations, burning fuels, using phosphate fertilizers and disposing of metal products, according to the U.S. Environmental Protection Agency. It can enter the bloodstream through ingesting cadmium-contaminated food and water and by breathing contaminated air. Cigarette smoke is another source of exposure.

For the study, published in December in the *American Journal of Epidemiology,* the researchers analyzed blood and urine samples from more than 6,700 U.S. adults who participated in a nationally representative survey. People with the highest concentrations of cadmium in their bloodstream had telomeres that were about 6 percent shorter than those in the lowest group. Their cells looked on average 11 years older than their calendar age. *—Lauren Ingeno*

IN BRIEF

STUDY: GENDER-DIVERSE OFFICES MORE PRODUCTIVE, LESS HARMONIOUS

When men and women work together it's better for business—but both sexes seem to prefer working in homogenous groups. Researchers at the George Washington University and the Massachusetts Institute of Technology looked at eight years of diversity and performance data and employee surveys from a firm with offices in the United States and abroad. The findings, published last year in the *Journal of Economics & Management Strategy,* suggest that switching from a homogenous office to one evenly split between sexes "would be associated with a revenue gain of 41 percent," says GW economist and study co-author Wally Mullin.

QUITTING? THERE'S AN APP FOR THAT

More than 11 percent of smokers enrolled in a smoking cessation text-messaging program quit the habit and remained smoke free at the end of a six-month study, compared to 5 percent of controls, according to researchers from the Milken Institute School of Public Health. The National Cancer Institute-funded study involved the program Text2Quit, which is licensed by GW to Voxiva Inc. The research was published online in June in the *American Journal of Preventive Medicine.*

$2.7M FOR MIDEAST, ASIA STUDIES

Elliott School of International Affairs research institutes focusing on the Middle East and Asia received $2.7 million in grants last fall from the U.S. Department of Education's Title VI program. The Institute for Middle East Studies received two awards totaling more than $1.8 million: a designation as a National Resource Center and grant funding to support students' language training and regional studies. The Sigur Center for Asian Studies also received more than $900,000 to help advance the study of East Asia, including Chinese, Japanese, and Korean language study.

PROGRAM TO BUILD TEACHING TRACK FOR STEM MAJORS

The Graduate School of Education and Human Development and the Columbian College of Arts and Sciences announced this year that GW was selected by the National Math and Science Initiative to receive a $1.45 million grant to launch a program aimed at expanding the pipeline of science, technology, engineering and math teachers. Modeled on UTeach, an initiative founded at the University of Texas-Austin, the program will offer undergraduate STEM majors coursework to prepare them for certification as D.C. public school math and science teachers.

SHELF LIFE

Nikki Usher

MEDIA

INTERVIEWING THE INTERVIEWERS

***The New York Times* has supplemented its well-known mandate of publishing "All the News That's Fit to Print" with "All the News That's Fit to Click"—a journey that has been neither smooth sailing nor unexciting in its prospects, writes GW professor Nikki Usher.**

Even if rumors of journalism's demise are premature and exaggerated, it's no secret that the industry is in crisis and must evolve to meet a new digital landscape. There is, surely, no better front seat to observe that transition as a scholarly fly on the wall than the newsroom at *The New York Times,* which is precisely where Nikki Usher, an assistant professor at the School of Media and Public Affairs, set up shop for an estimated 700 hours during the first six months of 2010. Dr. Usher spent most of her time at the Gray Lady's business desk and paid careful attention to the ways that three "core values of online journalism—immediacy, interactivity and participation—emerged as points of tension and change," she writes.

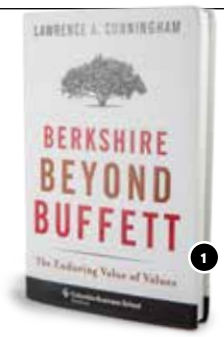
These three values orient journalism in the new online world. "Journalists must reckon with how to adjust to the demands of a 24/7 news cycle [and] an environment of interactive engagement," she writes. "... The result has been a restructuring of news routines, albeit in a contested way." Objectivity, the age-old news value, remains a factor, according to Dr. Usher, but it has perhaps been displaced somewhat by journalists' new marching orders.

There are challenges in trying to pin down a speeding target in book format, Dr. Usher admits. "Yet there are some underlying themes that remain the same regardless of the technological change," she says. While her book captures a moment in the history of a particular newspaper, it tells a story "about the clash of old and new that has been repeated over and over again throughout the history of news."

Since completing her research in 2010, Dr. Usher has noticed considerable changes in the field. The biggest, she says, has been the evolution of "analytics," or measurements to track online user behavior—metrics that are becoming increasingly important in editorial decision-making and to advertisers. "Yet at *The New York Times,* analytics are only beginning to make major inroads, as company interviews and documents suggest that many journalists only have a cursory understanding of their meaning," she says.

—Menachem Wecker

***Making News at The New York Times* (University of Michigan Press, 2014)**
Nikki Usher, assistant professor of media and public affairs



***Berkshire Beyond Buffett: The Enduring Value of Values* (Columbia Business School Publishing, 2014)**

Lawrence A. Cunningham

Since this book was published in October 2014, Warren Buffett's behemoth conglomerate, Berkshire Hathaway, has been anything but still, using its Procter & Gamble stock to buy Duracell, among a host of moves. That's par for the course. But so too is Berkshire's rock-steady culture and philosophy, which is something of an anomoly among large U.S. corporations, says Mr. Cunningham, a research professor of law. "It is more like what is found in smaller business partnerships. Berkshire shareholders think of themselves as owners or partners, while managers see their role as stewards," he says. "Throughout the organization, overhead is kept low, loyalty is prized, individual autonomy promoted, entrepreneurship stimulated, and capital allocated shrewdly."

***Narcissism and Politics: Dreams of Glory* (Cambridge University Press, 2015)**

Jerrold M. Post

Narcissus, of Greek mythological notoriety for falling fatally in love with his own reflection, epitomizes the Facebook-addicted "me generation." The "apparent epidemic of narcissism" doesn't infect all politicians, writes Dr. Post, GW professor of political psychology, but the "arena of public service and its limelight is particularly attractive, indeed irresistible, to individuals with narcissistic propensities."

***Constructive Illusions: Misperceiving the Origins of International Cooperation* (Cornell University Press, 2014)**

Eric Grynaviski

This book topples what is surely conventional wisdom—that the parties at the international diplomatic bargaining table ought to come to the best understanding of one another possible. Dr. Grynaviski, an assistant professor of political science and international affairs, instead writes provocatively that global cooperation is often likeliest when countries erroneously believe that they have much in common. "Actors may cooperate," he writes, "precisely because they lack mutual understanding."

***The Last Blank Spaces: Exploring Africa and Australia* (Harvard University Press, 2013)**

Dane Kennedy

British explorers tended, at least initially, to treat the continents of Africa and Australia as if they were uncharted oceans, which needed to be mapped and logged carefully using the best scientific instruments and techniques. That changed when boots hit the ground, according to Dane Kennedy, the Elmer Louis Kayser Professor of History and International Affairs at GW. Locals proved much more useful. "Where [explorers] went and how they got there was often predicated on what they learned from guides, go-betweens, and other indigenous peoples," he writes. "So too was their access to food, water, shelter, and other necessities." Explorers also weren't the independent actors they might now seem, operating through sheer force of will. Dr. Kennedy says he initially shared "many of the stereotypical notions of who the explorer was and what motivated him, and was surprised to discover that the reality was far more complex and interesting."

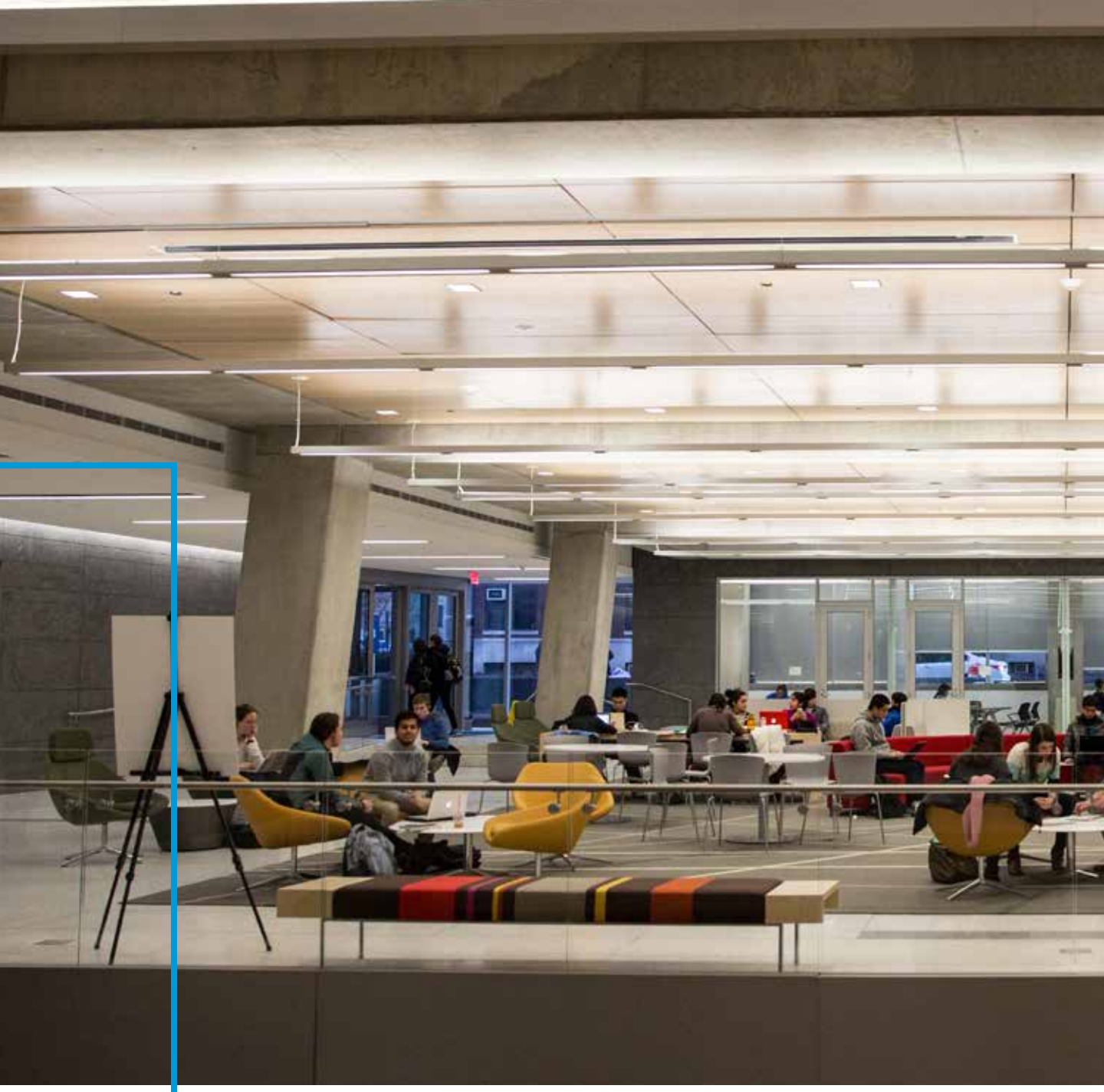
ALL: WILLIAM ATKINS

RESEARCH CAPITAL

The new Science and Engineering Hall opens to a mosaic of researchers—from biologists to aerospace engineers—seeking common ground in the pursuit of uncommon solutions.

BY LAUREN INGENO

WILLIAM ATKINS

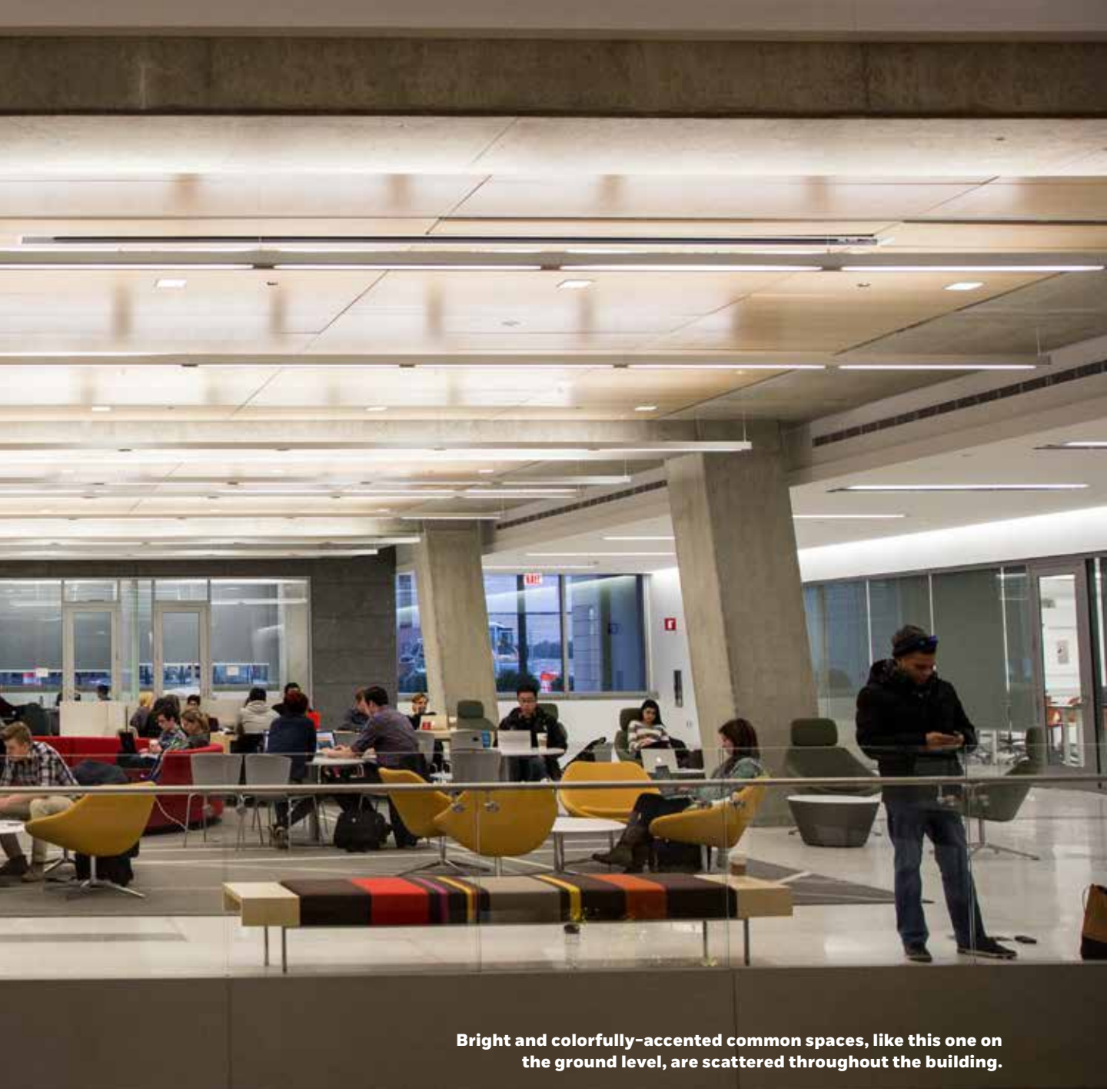


When the doors of Science and Engineering Hall opened in January, it signaled the culmination of nearly a decade of planning and four years of construction—a demolition, a dig and a steady climb skyward from the bottom of a 75-foot hole. But the new year brought the start of something even bigger.

For some academic departments, the building's opening marked a reunion, reconnecting colleagues and experiments that had been scattered among the nooks of a space-squeezed city campus. It also is a place to build new connections and cover new ground. And for many faculty and student researchers, the building's long-awaited opening ushered in an era of inquiry and opportunity at GW that previously was merely the stuff of daydreams.

For years, the growth of the university's research profile outpaced its infrastructure. Engineers converted dusty storage rooms into makeshift laboratories.

WILLIAM ATKINS



Bright and colorfully-accented common spaces, like this one on the ground level, are scattered throughout the building.

Scientists conducted experiments in crowded basements and carpeted labs. Graduate students traveled four times per week to build nanodevices at the National Institute of Standards and Technology, 25 miles from campus. GW's only transmission electron microscope—for viewing fine details in minuscule specimens—lived underneath the Lisner Auditorium stage.

And yet, they made it work. The university has climbed into the top tier of research schools, as counted by the influential Carnegie Classification of Institutions of Higher Education. And research expenditures—a key measurement of an institution's research activity—ballooned by 80 percent between 2003 and 2012, to nearly $200 million.

"The one thing that connects generations of GW engineers and scientists is that we studied in really crummy facilities. And it made us scrappy," Board of Trustees Chair Nelson Carbonell, BS '85, said in 2011, then as vice chair, at the building's groundbreaking.

Science and Engineering Hall, located at 22nd and H streets NW, sits at the site of the former University Parking Garage.

"You can't underestimate the importance of geography … And that's the point of the building—it might actually induce biological anthropologists to have lunch with electrical engineers. And then who knows what might happen?"

ANTHROPOLOGY PROFESSOR
CHET SHERWOOD

"GW scientists and engineers can do a lot with a little," he said. "But just imagine what we can do with a lot."

THE NEW BUILDING—eight stories above ground and six below, including four levels of parking—is located on the former site of the University Parking Garage at 22nd and H streets. It brings together research and teaching spaces previously spread across a dozen buildings. And it nearly doubles the space on campus available to a variety of science and engineering programs.

Science and Engineering Hall houses a growing roster of researchers that, for now, comprises around 140 faculty members from 10 departments, including all six from the School of Engineering and Applied Science and four disciplines from the Columbian College of Arts and Sciences. The mix ranges from computer scientists and aerospace engineers to physicists and biologists. They will be joined, likely in 2016, by some of the researchers from the Milken Institute School of Public Health and the School of Medicine and Health Sciences when the top two floors are completed.

"This building likely will hold the most diverse amount of combined science and engineering of any building that you could find in the United States," says Rob Voss, a project architect at Ballinger, the firm that designed the new building.

Faculty members share four specialized labs: a three-story "high bay" for large-scale experiments, an ultraclean nanofabrication lab, a greenhouse and an imaging suite equipped with microscopes for viewing objects at resolutions better than one billionth of a meter.

The building will put the university and the city "at the center of scientific innovation," GW President Steven Knapp said after the concrete structure reached its full height, in late 2013.

"Washington, D.C., is often thought of a city of power and policy," he said. "But for us to have credibility in the

ILLUSTRATION: VIRTUALTOUR.GWU.EDU

future in the policy realm, we need to also have authority in the realm of technology, science and engineering."

The city is very much what distinguishes this facility from research buildings at other college campuses throughout the country, officials say. At a grand opening celebration in March, Dr. Knapp mused: "I remain confident that this is the largest science and engineering building that will ever be built within six blocks of the White House." And that proximity to corridors of power—including Capitol Hill, the National Institutes of Health, the National Science Foundation and the National Academy of Sciences (the president of which spoke at the grand opening)—is already a tangible advantage.

The building has not only attracted researchers to GW, officials say, but it's also a magnet for equipment manufacturers and other potential industry partners looking to have a presence in a brand-new, high-visibility space. It has already resulted in deals involving showcase-level microscopes.

"It's an impressive building in an impressive location," says Can Korman, associate dean for research and graduate studies at SEAS, and the lead academic representative from SEAS in the planning of the building. "There are a lot of great buildings in the middle of cornfields."

But GW's largest capital construction project didn't come without challenges. The construction site shared a city block with three residence halls, a D.C. traffic artery and, below ground, a Metro tunnel. The building required elaborate planning and delicate maneuvering by engineers, architects and construction crews.

The imaging suite and nanofabrication lab, for instance, are engineered to dampen vibrations from the Metro. And instruments that use electrons for imaging and etching nanoscale devices needed to be shielded from the magnetic fields produced by the subway's high-voltage rails.

"Whether you're trying to see things or build things at the nanometer scale, you want to make sure those little electrons are going right where you want them to go," Dr. Korman says.

On top of that, the university challenged designers to build the nearly 500,000-square-foot facility without multiplying GW's carbon footprint. The end result is an academic building that is unparalleled at GW in scope and function, as well as eco-friendly. Among the building's sustainable features, the roof protects the building from the heat of the sun, heat from the building's exhaust air is captured and transferred to incoming air, and rainwater is collected and reused to flush toilets.

BY THE NUMBERS

140

Faculty members, approximately, stemming from 10 departments across CCAS and SEAS, who took up occupancy when the building opened. A slate of researchers from medicine and public health will follow.

12

Number of buildings on campus from which CCAS and SEAS faculty members came to SEH.

8,100

Metric tons of carbon dioxide saved each year—more than half of the building's would-be carbon footprint—as a result of sharing Ross Hall's co-generation power system; that's the equivalent of taking nearly 1,500 vehicles off the road.

500,000

Approximate square footage in the building.

AS MUCH AS Science and Engineering Hall is about new facilities and bringing together departments, it's also about looking beyond the bounds of traditional silos. In an effort to encourage that, many of the building's work spaces are surrounded by glass, putting research and classroom activities on display.

"We want people to be curious, to look in and say, 'Hey, what are you doing in there? Maybe I can help you,'" says Jason Zara, a professor in the Department of Biomedical Engineering. "With funding getting tighter every year, research is really moving in a much more interdisciplinary direction."

Faculty members are grouped into so-called research neighborhoods, which concentrate researchers with overlapping interests, like researchers from the Center for the Advanced Study of Human Paleobiology. After outgrowing their townhouse office and being scattered around campus, they are together and surrounded by chemists, biologists and engineers.

One of the center's researchers, anthropology professor Chet Sherwood, is on a floor that shares a kitchen and common space with the Electrical and Computer Engineering Department on the floor below.

"You can't underestimate the importance of geography," he says. "And that's the point of the building—it might actually induce biological anthropologists to have lunch with electrical engineers. And then who knows what might happen?"

Officials say that combined with the building's shared specialty labs, the university is now positioned to propel the innovative ideas that could result from those collaborations.

In the past, GW researchers often were "supporting actors" on larger institutions' multimillion-dollar grants—not because of "lack of brainpower," says

UNDER ONE ROOF

At any moment in the new Science and Engineering Hall, researchers could be testing the strength of bridge beams and peering at samples magnified a million times, while students learn, electric cars charge and lunch is served at a new street-level eatery from renowned chef José Andrés.

Within that flurry of activity, new bonds and perhaps even innovative collaborations will be formed among the researchers from a variety of disciplines that ultimately will be represented in the building:

- Biology
- Chemistry
- Physics
- Anthropology
- Civil & Environmental Engineering
- Computer Science
- Electrical & Computer Engineering
- Engineering Management & Systems Engineering
- Mechanical & Aerospace Engineering
- Biomedical Engineering
- Researchers from the Milken Institute School of Public Health
- Researchers from the School of Medicine and Health Sciences

Explore Science and Engineering Hall further at *seh.gwu.edu.*

CORE LAB FACILITIES

HIGH BAY
This expansive, three-story lab—with a glass wall facing 23rd Street to invite onlookers—features a 20-ton crane and a reinforced, 28-foot-high "strong wall" and "strong floor" to test the strength of enormous objects, like bridge beams.

› NANOFABRICATION LAB
An intensely clean environment where researchers build and work with devices that measure mere billionths of a meter. To do that, the air is scrubbed of contaminants like dust, dead skin and hair, relative giants that can destroy experiments.

› IMAGING SUITE
Five rooms—specially built to dampen vibrations from the nearby Metro—housing high-resolution microscopy equipment, such as a new transmission electron microscope that can magnify samples by 1 million times.

› ROOFTOP GREENHOUSE
Anticipated to open in 2016, the space will be climate-controlled to help plants endure the high summer heat.

ALL: WILLIAM ATKINS

One of several plant-covered "green walls" that enliven the building's common spaces.

TEACHING & COLLABORATIVE SPACES

"TEACHING TOWER"

A stack of 1,000-square-foot, fish-bowl teaching labs at the building's center, from the third floor to the eighth floor. They include labs for software engineering, circuitry and robotics.

› LEHMAN AUDITORIUM

The room, named in honor of Donald R. Lehman, PhD '70, professor emeritus and former executive vice president for academic affairs, offers flexible space for teaching and major lectures and symposia.

› COMMON AREAS

Tables and chairs dot broad common areas where students can do homework and researchers can meet; there are banks of open workstations and nooks for student clubs. From the third floor on up, a spiral staircase links each pair of floors with a two-story atrium that fills with light from a wall windows.

› STUDIO LAB

Integrated lecture and lab space that is geared toward a more hands-on classroom experience. It can fit 72 students as one room or be converted into three separate spaces.

SUSTAINABLE BY DESIGN

› A ROOF THAT KEEPS COOL

Vegetation covers more than 10,000 square feet of the roof, keeping the building cool by absorbing heat from the sun while also reducing rainwater runoff. The rest of the roof was made light in color so those areas would reflect heat, too.

› CO-GENERATION SYSTEM

The building gets 80 to 85 percent of its power from a green co-generation system in the utility plant at Ross Hall, across the street, which captures and recycles steam to generate electricity and heat for both buildings.

› OTHER FEATURES

Graywater Use
Rain from the roof drains into a 42,000-gallon cistern to be filtered and used to flush toilets, saving roughly 850,000 gallons of water per year.

Chilled beams
Horizontal beams suspended from the ceiling use water to cool the air more efficiently than a conventional air-conditioning system.

Electric Car Charging
The underground, 386-space parking garage includes the second electric car-charging location on the Foggy Bottom Campus (the other is nearby, in the Academic Center).

Energy Recovery Wheels
This technology recycles conditioned air from the building in order to heat or cool incoming air, reducing energy needs. The savings are expected to pay for the system in less than three years.

Refill Stations, Lockers & Showers
To encourage the use of reusable water bottles, refill stations are located outside every restroom. Lockers and showers encourage exercise.

Think Tank

From biomedical engineers and chemists to anthropologists and computer scientists, Science and Engineering Hall is a melting pot of expertise, ideas and high tech. These faculty researchers are among the initial 140 or so who are bringing the corridors to life.

‹ Amy Zanne
PLANT PHYSIOLOGY & EVOLUTION

Explores plant traits in order to understand the links between a plant's structure and its function. Recently led a team that assembled the largest time-pegged evolutionary tree of flowering plants, showing how they evolved to tolerate cold winters.

Volker Sorger ›
NANOPHOTONICS

Squeezes light into spaces just a few nanometers wide to more efficiently power smartphones and computers. With a new NSF grant, he's launching a program that will give students experience with nanotechnology earlier in their academic careers.

‹ Akos Vertes
CHEMICAL ANALYSIS

Developing tools to rapidly identify the root cause of biological and chemical threats. Under a $14.6 million award from the U.S. Defense Advanced Research Projects Agency, or DARPA, Dr. Vertes and his team are tasked with reducing to 30 days a process that can take years.

Grace Zhang ›
TISSUE REGENERATION

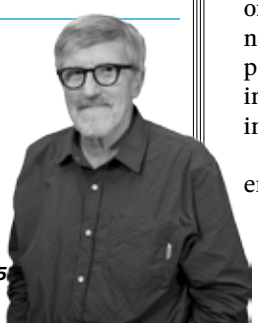
With a $2 million New Innovator Award from the NIH, creating a 3-D bioprinting technique to enable the regeneratation of complex tissues, such as vascularized bone, cartilage and muscle, that has been damaged by injury or disease.

‹ Rumana Riffat
WASTEWATER TREATMENT

Finding solutions for water pollution and shortages in communities around the world, from developing a small-scale water treatment and reuse system in Pakistan to current research evaluating a high-rate process for removing carbon and nitrogen from wastewater in D.C.

Bernard Wood ›
HUMAN ORIGINS

Studying ways to better classify and reconstruct evolutionary relationships among hominini, the lineage that led to our own species, *Homo sapiens*, with a particular focus on skull and tooth fossils.



Dr. Korman, but rather, lack of proper facilities.

"Now we're in a position to be a major player for these larger grants," he says.

The nanofabrication lab, for instance, will allow engineers like Volker Sorger to conduct his research in Foggy Bottom, instead of traveling to federal labs or outsourcing to other universities. After completing a PhD at University of California at Berkeley in 2011, Dr. Sorger says the promise of Science and Engineering Hall is part of what attracted him to the electrical and computer engineering faculty.

Dr. Sorger works in nanophotonics, or light at the nanometer level, a space about 100,000 times smaller than the width of a human hair. He is seeking to develop technology that could harvest its energy to power laptops or smartphones. Other GW researchers are building nano-scale sensors to detect small volumes of toxins or to enable devices to diagnose medical conditions using a single drop of blood or urine.

At the opposite end of the spectrum, Science and Engineering Hall's three-story high bay will allow engineers like Sameh Badie, in the Department of Civil and Environmental Engineering, to work on outsized projects that will help build safer, more earthquake-resistant bridges and buildings. Dr. Badie conducts experiments on reinforced and prestressed concrete structures that are sometimes in the range of 45 feet long and 8 feet tall. Since the facilities at the engineering school's Tompkins Hall could not accommodate those large structures, in the past Dr. Badie often needed to hand off his projects to institutions with larger facilities.

The enormous room also could benefit researchers like Philippe Bardet, in the Department of Mechanical and Aerospace Engineering, who needs a high ceiling for his studies on the fluid dynamics inside nuclear reactors.

FOR STUDENTS, TOO, the building offers exposure to new research opportunities and modern learning spaces.

"Instead of this being a drag that you have to go to lab for four hours, you are going into a lab that inspires you, a lab where you want to learn," says chemistry professor Susan Gillmor.

All chemistry labs will be taught in the building starting this year. With larger labs, the department will be able to offer more spots in introductory classes. And the new teaching spaces create "few barriers among students, and also between the students and the instructor," professor Cynthia Dowd says.

In a departure from the traditional lab layout—rows of workstations arranged behind one another—the new chemistry rooms have lab benches that line the perimeter. Tables for discussion and collaboration sit in the center, intended to encourage more face-to-face interaction.

The building also features a reconfigurable engineering "studio lab" on the ground floor, a hybrid

VERTES: JESSICA MCCONNELL BURT / OTHERS: WILLIAM ATKINS

“GW scientists and engineers can do a lot with a little. But just imagine what we can do with a lot.”

BOARD OF TRUSTEES CHAIR NELSON CARBONELL, BS ’85

Researchers moved into new work spaces, like this chemistry lab, in January. Along with a suite of core lab facilities and more immersive teaching spaces, the building is being called “transformational.”

lab and lecture space designed to facilitate hands-on activities. The studio lab has room for 72 students and can be switched from, say, a mechanical engineering lab to one for electrical engineering by pushing carts of equipment into storage space in the walls. It also can be divided into three separate rooms.

The glass-walled, collaborative atmosphere of the building will also make it easier for students to find research opportunities, says student Elizabeth Hubler, BS ’14, who is staying at GW to pursue a master’s degree. After a freshman year class with Michael Plesniak, chair of the Department of Mechanical and Aerospace Engineering, she became involved in Dr. Plesniak’s fluid dynamics lab and has stayed ever since. In the lab, she is working to improve a simulated human vocal tract, which could be used to treat voice disorders.

“I think the new building will bring a lot more chances for undergrads to get involved in research, just because there will be so much more visibility,” Ms. Hubler says. The group’s former lab space was in Staughton Hall. “Most people don’t even know where that is,” she says. That fragmentation made it “hard for undergrads to really see the types of projects faculty are working on.”

The building also has a scaled-down teaching version of the superclean nanotechnology lab—a rarity on college campuses, officials say—that will be used to train researchers and expose students to the art of nanofabrication early on in their academic careers.

A grant from the National Science Foundation will fund a new nanofabrication course co-taught by three SEAS faculty members, as well as a nanotechnology fellowship program led by Dr. Sorger, the nanophotonics researcher. The grant will allow 10 freshmen and sophomores to work and learn in the teaching clean room this summer. Next year, those students will lead the new cohort of undergraduate fellows.

“We really want to create nanotechnology ambassadors. We want to win them very early on,” Dr. Sorger says. “And once we hook them into nano, they don’t leave.”

That potential surrounding Science and Engineering Hall is part of the energy that drew Dr. Sorger to GW in the first place. He sees the building as a launchpad, and he’s in good company around campus: Among administrators and the researchers who were heading into the building, the word “transformational” tended to follow “Science and Engineering Hall” like a last name. That excitement has seen the building through from lines on paper to concrete pillars and, finally, to bright new labs and classrooms.

The outcomes that will be forged there are unknown but, for many, the possibilities seem endless.

“The size, the investment and the momentum behind the building ... it’s very exciting,” Dr. Sorger says. “We can really build something here.” GWR

WWW **The expansion of research facilities and opportunities for students and faculty members is a pillar of GW’s $1 billion philanthropic campaign. For more details, visit campaign.gwu.edu.**

WILLIAM ATKINS

A dramatic sky looms over the greenery in an area on the outskirts of Juba, the capital city, near a United Nations Protection of Civilians camp.

MARY ELLSBERG

ON THE SIDELINES OF THE CIVIL STRIFE THAT HAS LONG EMBROILED THE PEOPLE OF SOUTH SUDAN, WOMEN AND GIRLS ARE IN THE CROSSHAIRS.

ACTS OF WAR

The world's newest nation is also one of its most volatile. South Sudan emerged in 2011, rising from nearly a half century of civil wars. But by the end of 2013, ethnic conflicts had erupted again in warring that has been marked by gender-based violence. "The bodies of women and children are the battleground of this conflict," the United Nations' special representative on sexual violence in conflict, Zainab Hawa Bangura, said last fall after visiting one of the war's hot spots.

GW Global Women's Institute Director **MARY ELLSBERG** and research director Manuel Contreras traveled to the fledgling country last August. They were preparing for potentially groundbreaking research that aims to estimate the scope of gender-based violence in South Sudan and to better understand its causes and consequences, while also attempting to create a standard for measuring this kind of violence in conflict zones the world over. The study, proposed during South Sudan's window of peace, is now taking on new dimensions of urgency, danger and complexity, as the researchers try to measure the violence of war in real time.

After the trip, Dr. Ellsberg spoke with **DANNY FREEDMAN** about the project and its relevance.

What do we know already about violence against women and girls in conflict zones?

We've known for a long time that rape exists in war. Now there's a recognition that, in some cases, it's on a massive scale and used as a tactic of war. We saw it in Bosnia and Herzegovina, we saw it in Rwanda, we're seeing it in Democratic Republic of Congo and in South Sudan.

In many places, rape is not just an opportunistic crime, it's actually part of fighters' tactics to demoralize villagers and to terrify them. And it's done in horrendous ways that are meant to completely devastate families and whole communities.

Domestic violence also increases in times of conflict, and when women are getting displaced, for example, this gets piled on to their already extreme vulnerabilities to child sexual abuse and to sexual assault in communities.

So that's what we do know; there's a lot that we don't know.

We have pretty good methods now for doing this kind of research in non-conflict circumstances. We've also done some research in postconflict settings. But how to apply those methods to an area that's in complete upheaval—I think there's been some skepticism about whether it can be done.

But the fact is: If you don't have good data, it's much harder to convince people to invest in solutions. So what we're doing is figuring out how to adapt and apply some of these tools, this rigorous scientific method, to an area that's so fluid.

What's the goal of the study?

We're trying to understand the prevalence, the triggers and the characteristics of gender-based violence in both the most recent conflict and earlier conflicts in South Sudan. That's going to be going on for a couple years. Then we're going to help design and evaluate an intervention for violence prevention.

The research is part of a broader five-year program led by the International Rescue Committee, along with us at GWI and CARE International, called "What Works to Prevent Violence Against Women and Girls in Conflict and Humanitarian Emergencies," which is funded by the United Kingdom's Department for International Development.

There are no measures for this kind of violence in war zones?

Only a few studies have been done. And here's another problem: Everybody's using different questionnaires, their methods are different, so the results aren't comparable. That's the problem we had with studying domestic violence years ago. As a result, there was the World Health Organization's Multi-country Study on Women's Health and Domestic Violence against Women in 2005, which I was a part of, that was really the first effort to have a standard methodology that would allow us to compare the levels of violence across different settings.

For the South Sudan study, to ensure that we're building on best practices for this kind of research, we convened a meeting in February with researchers and other stakeholders from all over the world. They shared their experiences with interviewing methods, like face-to-face with iPads or on paper; ways to make it safe and comfortable for people to disclose violence; safety issues; how we measure and how we define violence, those kinds of things—so we can try to develop the gold-standard instrument. That's our goal here.

Why South Sudan?

In July 2013, we proposed a set of different studies that we thought would contribute to the gaps in the evidence, and we wanted a place where we could conduct both qualitative and quantitative research on the prevalence and drivers of violence. We thought of South Sudan because it was newly independent, and we were hearing really positive stories. There was a feeling that the people there had been through so much, and here they are finally getting a chance to move forward as an independent country and live in peace. It was a real time of optimism.

There also were no data on gender-based violence, the government was interested in learning more, and it's a place where they could actually use the data for programs.

That's how we proposed it. In November we got word that we received the contract, and in December everything blew up and civil war was back on. In some ways the research is just as important, or even more important, but it's definitely more challenging to do the research than we initially expected.

When we were there, the hardest thing was to choose where we would be able to do an ethnically diverse, representative study in six to eight months, because nobody knows where anybody's going to be then, or what places it will be possible to enter. It's just so fluid.

Hence calling this a feasibility visit. What did you find when you got there?

We were going to find out whether and where there were conditions on the ground to be able to do this research. With the conflict ongoing we had real doubts, we thought that it would be impossible to do. But talking to people on the ground, they wanted us to do the study. People felt it was important to document what was happening and to do it in real time, not wait till years later.

The first week we were in Juba, the capital, meeting with the rest of the local and international research

WILLIAM ATKINS

"The evidence showing that violence can be prevented sends a very powerful message. We're hoping to show that programs like this can be successful in postconflict settings, too."

team, government officials—we're working closely with the Ministry of Gender, Child and Social Welfare and the National Bureau of Statistics—United Nations agencies, health care workers and women's groups. We also went to possible study sites, including a Protection of Civilians camp in the surrounding county.

What was that like?

Everything is tense. People are living in very small tents, basically, each made out of one big sheet of canvas. It's hot, dusty; there's not a lot of food. Women have to leave the camps to look for food and firewood, and that's a big risk for getting raped. People are just hugely frustrated over the situation. It's a tinderbox, and that breeds more domestic violence.

In the second week, Manuel Contreras, our institute's director of research, traveled on to Rumbek in the central state of Lakes, to continue the assessment. Things are very tense there, too.

It was a packed trip. While we were there, and in our ongoing efforts with the technical advisory team I mentioned earlier, we're trying to get everybody's buy-in that what we're doing is useful and appropriate, both scientifically and culturally. At every step we're trying to do a lot of consultation to make sure that we're getting it right.

One of the lines we have to walk carefully on is: We're not doing this as human rights activists. The IRC is a humanitarian actor, and they have to be very careful to not appear to be taking sides. And we are public health researchers; we're trying to document the problem and, based on that, to raise the flag of awareness.

We also have to collect the data in a way that is completely impeccable, in terms of its transparency, its rigor, its objectivity, or it won't have credibility.

In the end, how are you going to be conducting the research?

Choosing the sites was important, because we had already decided that it would not be possible to carry out a nationally representative survey. We needed to find places that represent at least the three main ethnic groups: the Dinka, Nuer and Murle.

We ultimately settled on doing a door-to-door field survey in Juba County and the state of Lakes. Juba County is ethnically diverse and includes urban and rural areas, including two Protection of Civilians camps, while Lakes is largely rural and most of the people are Dinka. Lakes hasn't seen the kind of fighting that's going on in other areas, but there are conflicts between communities related to cattle rustling and bride prices that also increase women's risk of violence.

Those two sites will have both the quantitative study and qualitative work—interviews with survivors, humanitarian and health care workers, and others, maybe even perpetrators of violence. We'd planned on a third site, Unity state in the north, but that's one of the areas most affected by the war now. Going door-to-door would be too dangerous. So in order to try to still represent that state, which is mostly Nuer, we'll conduct only the qualitative piece there.

For the population survey, which will likely begin this fall, we'll be interviewing 2,000 women and 1,000 men. A few studies have reported sexual violence against men during conflicts, and though most of the people we talked with in South Sudan hadn't heard of incidents like that, it may be that it goes unreported

because of stigma. We'd like to gather data and see, one way or another.

So we'll be asking women and men about their experiences with domestic violence, sexual abuse in childhood and other violence they've witnessed or experienced during and before the current war.

The survey is door-to-door?

You get maps of each village and neighborhood—and the last census was in 2008, before South Sudan was even a country, so we'll be updating the maps as we go—and you randomly select, say, every sixth house systematically through the neighborhood. You find out who lives there. We're looking for women and men age 15 or older. If they have more than one, then we randomly select one and interview him or her.

The trick, then, is getting them alone. Sometimes you take them outside, you go sit under a tree, you go to the river where they're washing. That's a key piece of this, so they can feel comfortable talking about violence. It's such a stigmatized, sensitive issue that people often won't talk about it. But that secrecy is also important so the person doesn't face reprisals afterward.

We have a whole set of safety measures, developed by the World Health Organization, and that involves having dummy questionnaires, or if somebody walks into the room you change the subject and start talking about breast-feeding or immunizations, and these are all things that you discuss with the woman beforehand.

We don't tell the family that we're talking about violence. We tell them it's something about women's health and then when we get her alone we tell her what we're going to be talking about. We'll also have basic psychological and social services available, directly or by referral, both for the women in the study and for the interviewers. It's hugely stressful for interviewers to be listening to these stories, and a lot of times they've suffered abuse, too, so they need counseling as well during the process.

For everyone's safety and for the comfort of the people in the study, this piece will be done by trained local interviewers, matched with respondents by gender and ethnicity.

Is there anything that works to prevent this kind of violence?

We just published a review paper in a special issue of [British medical journal] *The Lancet* that looks at the effectiveness of different programs to prevent all forms of violence, including female genital mutilation, child marriage, domestic violence and sexual assault. And what we found was pretty interesting.

We did a review of all the rigorous studies we could find that aimed to reduce violence against women and girls. Most of the studies in the U.S. and Canada involved screening women for domestic violence or treatment for batterers through the justice system. We found that there is almost no evidence that these programs actually prevent future violence. They may have other benefits but, for the most part, relying on screening programs and batterers' treatment does not work to reduce violence overall.

We also now know a lot more about the drivers of violence. A big reason why there's more violence in one country than another, or even one community to another, has to do with social norms. When you're in a setting where 50 percent of the men are beating their wives, it's not because 50 percent of the male population are monsters. It's because it's socially acceptable, and if you don't beat your wife you're not considered to be a man. So deterrents through stronger laws—"you'll go to jail if you do this"—or better services are not going to change that. You have to work on making it not OK to beat your wife and talking about gender equality.

That sounds kind of touchy-feely. But now there have been a few rigorous, randomized, controlled trials that have shown that it is possible to prevent violence against women by changing social norms. One community mobilization program carried out in Uganda, called SASA!, reduced domestic violence by 50 percent in the study communities in two years. They just saturated the communities with messages about how harmful domestic violence was, not only to women but to families and communities. While many programs have focused on women, this one also included everyone from men and children to religious leaders, police, teachers and health workers. It has been hugely successful and is being adapted and scaled up in many countries. These are the types of interventions we think have the potential to make a lasting impact on violence worldwide.

The evidence showing that violence can be prevented sends a very powerful message. We're hoping to show that programs like this can be successful in postconflict settings, too.

In conflict settings, like South Sudan, our emphasis is on documenting the magnitude and types of violence women and girls are facing, and the kinds of basic measures that can make a difference in the acute phase, such as ensuring safe access to firewood and water. Often, women in refugee camps are raped when they have to leave the camps to look for firewood or food or to carry water.

Humanitarian groups are also paying a lot more attention to issues like sanitation. If the toilets are too far away, or if the women's toilets are too close to the men's toilets, or if people have to go at night and there's no lighting, that's when women get raped.

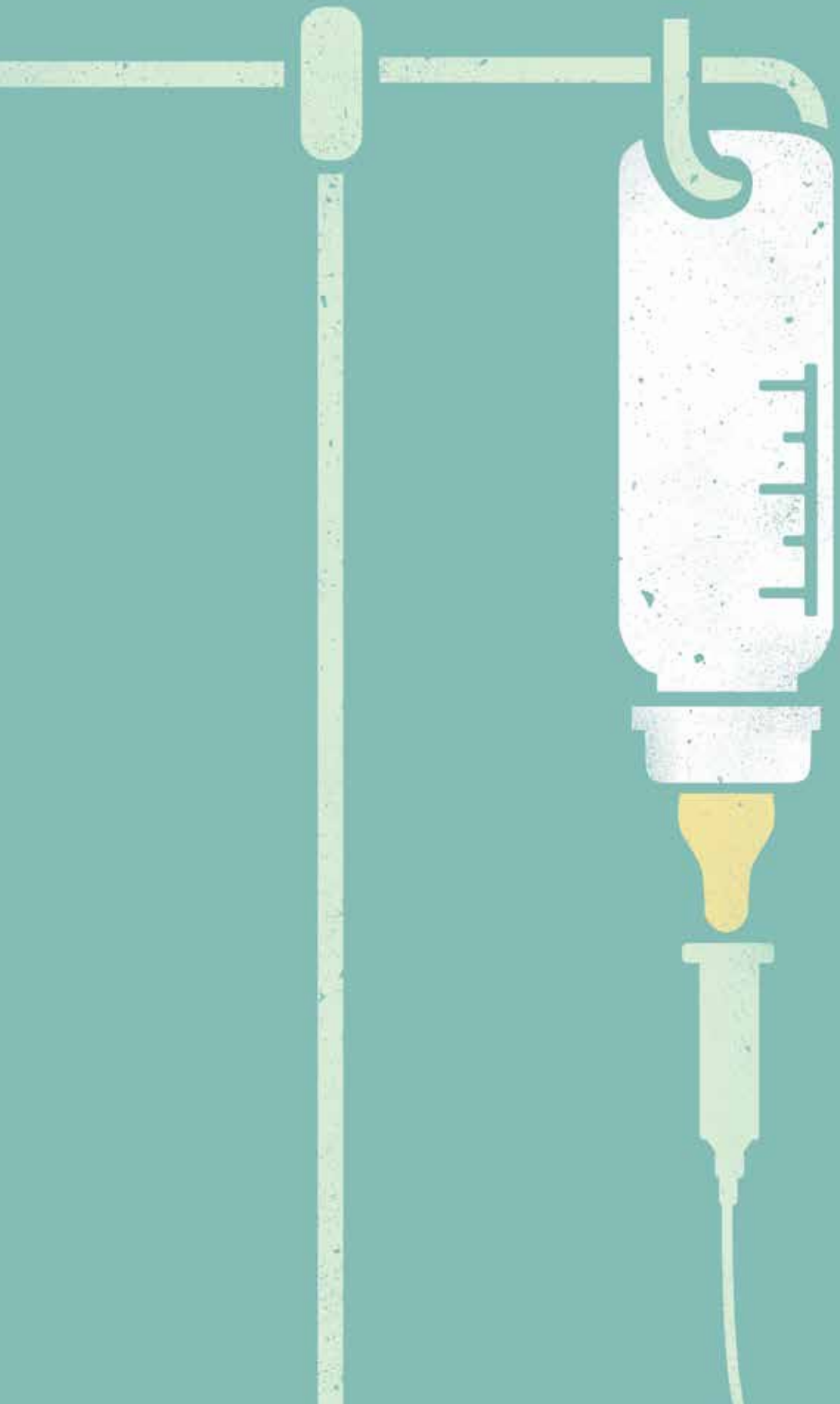
So even pretty simple measures around infrastructure and lighting—like access to charcoal, so women don't have to get firewood—can actually make a big difference in terms of women's safety in the camps. GWR

Reuniting Babies and their Bottles

For infants with disorders that leave them unable to eat, feeding tubes and surgeries offer an imperfect fix. The problem is in the brain, and that's where GW researchers are looking for a cure.

BY LAUREN INGENO

JOHN MCGLASSON



Monica Jennings could not eat when she was born prematurely at Boston's Brigham and Women's Hospital in 1994.

SHE would aspirate liquids, inhaling them into her lungs, which led to a series of ongoing pneumonia and sinus infections. Soon after birth, doctors inserted a tube into her nose to feed her, and at three weeks, put another in her trachea to protect her airway. Though they told her mother, Lisa, that the tubes likely would be temporary, they remained for more than a decade.

Ms. Jennings spent the first months of her daughter's life consulting geneticists, neurologists, speech therapists and gastroenterologists, but no one could tell her why Monica was unable to swallow. For two years, they called her symptoms a medical mystery.

"My sister and I lived together, and my nephew was born a few weeks after Monica. So I came home every night to this very healthy, very hungry, vocal baby. And I had exactly the opposite," Ms. Jennings says. "I couldn't feed her or hold her. Oh, it was brutal. Brutal."

Doctors finally diagnosed Monica with 22q11.2 deletion syndrome, or DiGeorge syndrome, a disorder that affects an estimated 1 in 4,000 people, though it may be more, as experts suspect it is underdiagnosed.

DiGeorge syndrome is caused by a small amount of genetic material missing on the long arm of chromosome 22. Most often, the deletion occurs at random and is rarely inherited from a parent.

The syndrome can lead to an extraordinarily large and diverse range of health and cognitive issues, from learning disabilities and language delays to heart defects and seizures, making it difficult to recognize.

But one of the most debilitating symptoms of DiGeorge, and the root of overwhelming anxiety for parents like Ms. Jennings, is the inability to properly chew, swallow and digest food.

Dysphagia, the medical term broadly applied to these symptoms, is a dangerous complication that affects not only DiGeorge patients but at least one-third of those with neurodevelopmental disorders, like Down syndrome and autism.

"It must be terrible, to be brand new in the world and every time someone comes at you with food it hurts," says Anthony LaMantia, a professor of pharmacology and physiology in the School of Medicine and Health Sciences and director of GW's Institute for Neuroscience.

And for patients like now 21-year-old Monica, it is an enduring battle. Though she first ate solid food—a banana—at age 13, Monica struggles daily with dysphagia and the health issues that stem from it.

Dr. LaMantia has been studying DiGeorge syndrome for more than a decade. He has primarily focused on disruptions in the development of the cerebral cortex, the part of brain that does the heavy lifting of memory, learning and cognition. However, as he talked to pediatricians, he realized they were spending a frustrating amount of time trying—to little avail—to relieve swallowing problems in DiGeorge patients.

"None of the clinical literature addressed, 'Why is this happening? And what can you do to fix it?' I thought that if you were going to solve a compelling problem, this would be it," Dr. LaMantia says.

In a 2013 study, Dr. LaMantia and a team of GW researchers reported finding that an existing, genetically-modified 22q11.2 mouse model exhibited all the major dysphagia symptoms found in DiGeorge patients—including issues with weight gain, swallowing and lung infections—opening the door to a more detailed look at the disruptions underlying the problem.

Analyzing the mouse model, the team found that issues with eating and swallowing were directly linked to a disruption in the embryonic development of cranial nerves—a dozen pairs of nerves that originate in the brain and carry out functions related to different senses in the body. The discovery reversed a common assumption that dysphagia symptoms arise after a child is born.

"It turns out that in the development of the earliest, prenatal steps that set up craniofacial structures—like

WILLIAM ATKINS

"I thought that if you were going to solve a compelling problem, this would be it."
Anthony LaMantia

the mouth and jaw—as well as the brain structures and nerves that control those muscles, something just isn't quite right," says study co-author Tom Maynard, an associate research professor of pharmacology and physiology.

Now, after three years of preliminary studies, Dr. LaMantia has assembled an interdisciplinary team of researchers from GW and Children's National Health System that will use the mouse model to understand how and why early brain disruptions lead to dysphagia in patients with developmental disorders.

The three-part project is funded by a $6.2 million grant from the National Institute of Child Health and Human Development and brings together a group comprising neuroscientists, geneticists, developmental biologists and clinicians. Along the way, the team will also consult with pediatricians and speech therapists at Children's National to see how they may be able to translate their research findings into clinical practice.

The research promises not only to define new therapies and prevention strategies that may improve the lives of those with DiGeorge syndrome, but may also have an impact far beyond those patients.

"If we can understand how the part of the brain that regulates this very simple, but very essential behavior of swallowing and food indigestion," Dr. LaMantia says, "that may give us insight and a framework about how neural circuits are compromised for much more complex behaviors that go awry in developmental disorders."

THE BROKEN BLUEPRINT

Though it seems like a simple, even automatic task, the act of eating is a complex orchestration of brain and body.

When all goes according to plan, food is chewed, mixed with saliva and positioned on the tongue for transport to the back of the mouth. Sensory receptors in the tongue and throat trigger the swallow, and the pallet rises and closes to prevent food from entering the nasal cavity. The voice box elevates to protect the airway, and food is routed into the throat.

"There is a whole process of preparing the food, directing it and keeping it on the right path," says Dr. Maynard, who studies cell signaling during neural development and will serve as co-investigator in two of the dysphagia project studies. "It actually takes fairly fine motor control, considering that most of us don't have to think about it."

In DiGeorge patients, various points in that sequence are broken. Doctors can surgically correct severe facial defects, such as cleft palate, in an attempt to alleviate dysphagia. But many children with developmental disorders who aspirate do not have any visible facial abnormalities. This suggests something is going haywire in the brain, rather than in their facial mechanics.

"As soon as any neural mechanism is involved, it becomes a much harder problem," Dr. LaMantia says. "You can recognize it clinically, but the underlying brain control of this behavior, and also the peripheral mechanism that must be put in place, is very complicated. Our ability to really fix it has been limited, because our knowledge has been limited."

The mystery mirrors cases of children with

1 in 4,000

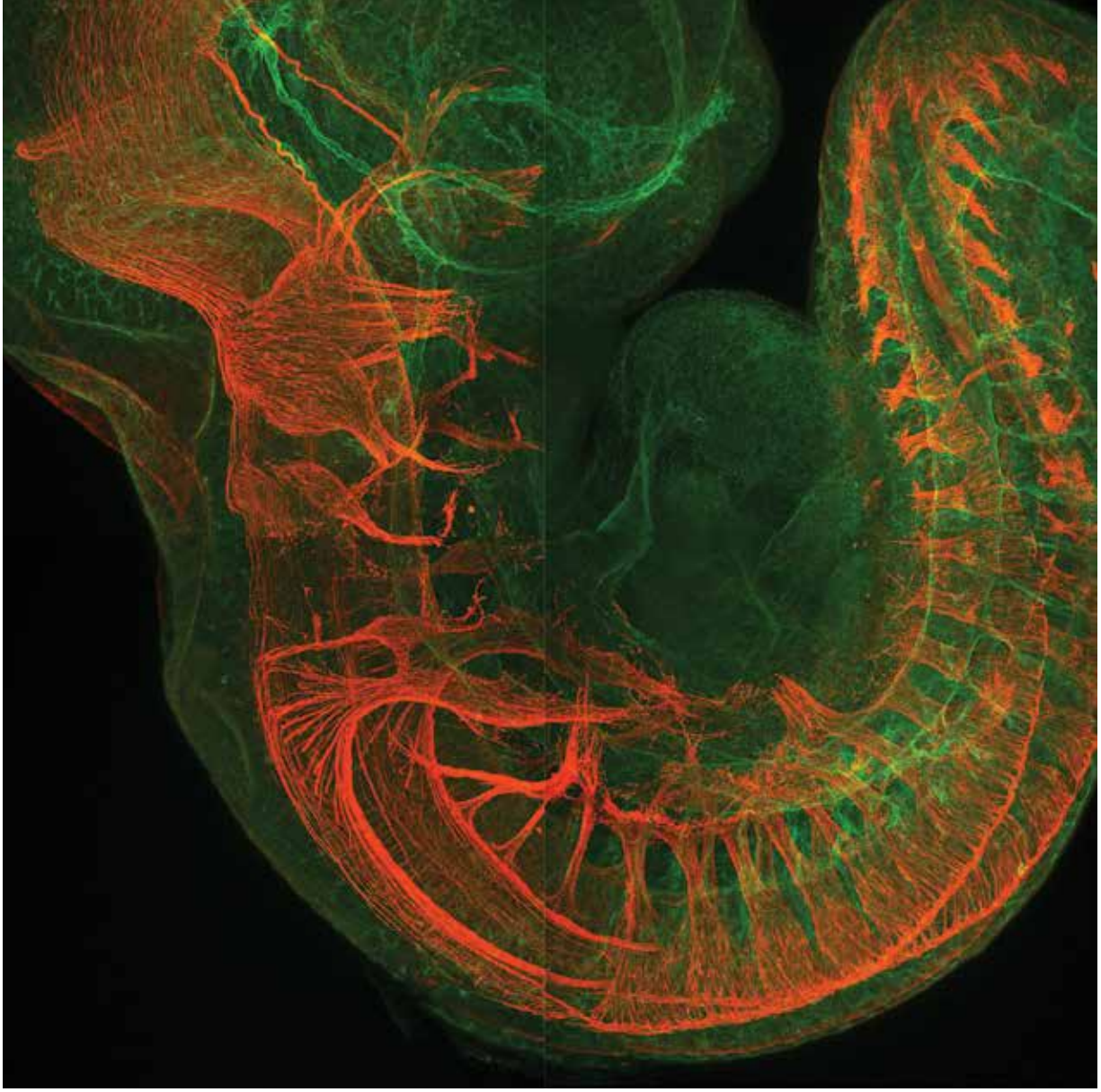
Prevalence of DiGeorge syndrome, though experts suspect it is underdiagnosed

35–80

Estimated percentage of people with neurodevelopmental disorders who are affected by dysphagia (difficulty eating)

$6.2 million

Amount of a new grant from the National Institute of Child Health and Human Development that brings together the efforts of seven GW faculty members



In this image of a 22q11.2 mouse model embryo, a red stain is used to make the nerves more visible, while blood vessels are highlighted in green. In 2013, Dr. LaMantia's team found that issues with eating and swallowing were directly linked to a disruption in the embryonic development of cranial nerves. The discovery reversed a common assumption that dysphagia symptoms arise after a child is born.

BEVERLY KARPINSKI, ANASTAS POPRATILOFF

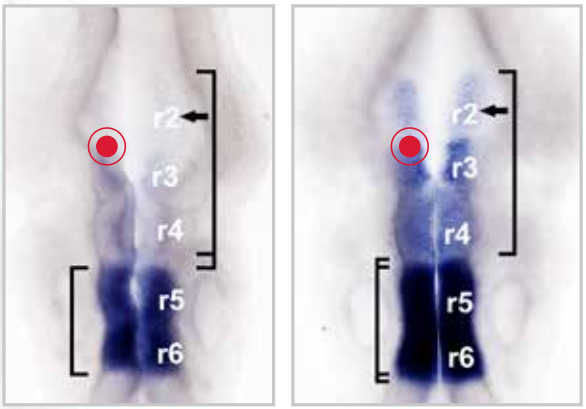
developmental disorders who have issues with eye alignment, which can lead to double vision. For years, doctors tried to correct these problems—often unsuccessfully—by operating on eye muscles. But the root of the issue was deeper.

"The surgery wasn't dealing with the problem," Dr. LaMantia says. "The problem was in the cranial nerve circuits in the brain stem that control eye movement."

The findings inspired Dr. LaMantia, who thought that those same disruptions could be causing dysphagia in DiGeorge patients.

Gene patterning in the embryonic brain stem lays out the blueprint for the proper development of the face, mouth, lips and jaw, as well as giving rise to the nerve cells that control feeding and swallowing. While analyzing the brain stems of the 22q11.2 mutant mouse models, Dr. LaMantia and his team discovered that gene expression levels and patterning in this region were highly disorganized. The brain's instruction booklet wasn't providing correct information to the face.

"We were able to show in the animal model that in a surprisingly classical, molecularly mechanistic way, the initial formation of that part of the brain was



Embryonic brain stems from a control mouse (LEFT) and a 22q11.2 mouse model (RIGHT) are stained to show, in blue, the expression of a gene. When the gene is overexpressed, as it is in the mouse model, cranial nerve development is disrupted.

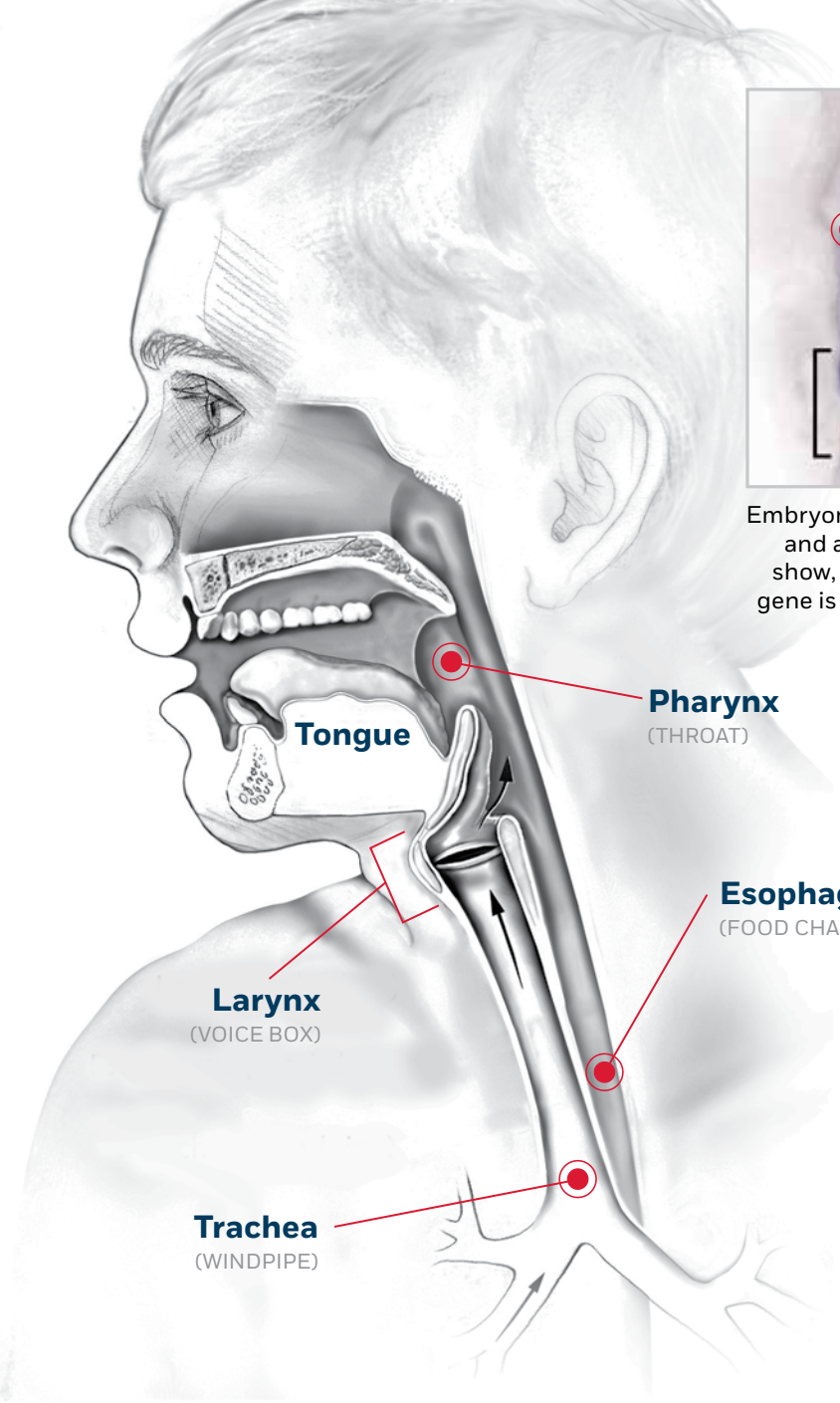


ILLUSTRATION: COURTESY NATIONAL INSTITUTE ON DEAFNESS AND OTHER COMMUNICATION DISORDERS / IMAGES: COURTESY ANTHONY LAMANTIA

The Food Network

Eating is an intricate orchestration of moving parts, from jaws to muscles to receptors, that ensures food is processed, pushed along and sent down the right path—and not to the lungs or nasal cavity.

disrupted," Dr. LaMantia says. "What we now have to figure out is what the consequence of that disruption is."

In their new project, Dr. LaMantia, associate director Sally Moody, a professor of anatomy and regenerative biology and an expert in craniofacial development, and Norman Lee, a professor of pharmacology and physiology who specializes in genomics, will investigate how these early interruptions establish changes in neural circuits in feeding and swallowing. They'll see how neurons in the brain stem develop and migrate during the prenatal period and what factors may cause that migration.

Simultaneously, David Mendelowitz, vice chair of the Department of Pharmacology and Physiology, will lead a study into whether the neurons in the brain that control feeding and swallowing may be misfiring in DiGeorge patients. He will work with Dr. Maynard, Dr. Lee and Anastas Popratiloff, director of GW's Center for Microscopy and Image Analysis, in these efforts.

"The question is, what's causing the swallowing difficulty? Is it the function of the individual motor neurons? Is it the sequence of events? Is it the timing or the magnitude of these changes?" Dr. Mendelowitz says.

By identifying the receptors or neurotransmitters that may be overactive or underactive in the brains of DiGeorge patients, Dr. Mendelowitz is hoping

that could lead to targeted therapies for improving dysfunctional swallowing.

From the various arms of the project, the team also hopes to better understand the variability of DiGeorge syndrome's kaleidoscope of symptoms. In the mouse model, the researchers saw remarkable variation among siblings, which should have nearly identical genetic make-ups. One goal, Dr. LaMantia says, will be to identify other genes underlying dysphagia in order to create a "genetic map of vulnerabilities," which could be used to predict or diagnose physical problems.

A DIETARY FIX

As the project got underway this spring, the researchers came into it with one idea for straightening out the circuitry that goes off course in DiGeorge patients.

Retinoic acid, the active form of vitamin A, is instrumental in the patterning of nerves that initiate swallowing. The researchers' 2013 study found that the 22q11.2 mouse embryos appear to be hypersensitive to even the smallest changes of the nutrient.

"Really high or low doses of retinoic acid can change those cranial nerves, so it makes sense that it would cause swallowing defects," says Irene Zohn, an associate professor of pediatrics at GW and a researcher at Children's National. "But it seems that the mice carrying the 22q11.2 deletion are not able to compensate for small ups and downs."

Dr. Zohn, a developmental biologist, will lead efforts to determine whether modifying the vitamin A intake in mouse model mothers could prevent dysphagia in their offspring.

"Our preliminary data shows that yes, things can change," she says. "But the question is: How much do all these changes come together to affect the physical abnormality?"

If the researchers do find a link between vitamin A intake and the emergence of dysphagia in people with DiGeorge syndrome, clinicians may be able to offer corrective dietary guidelines for expectant mothers.

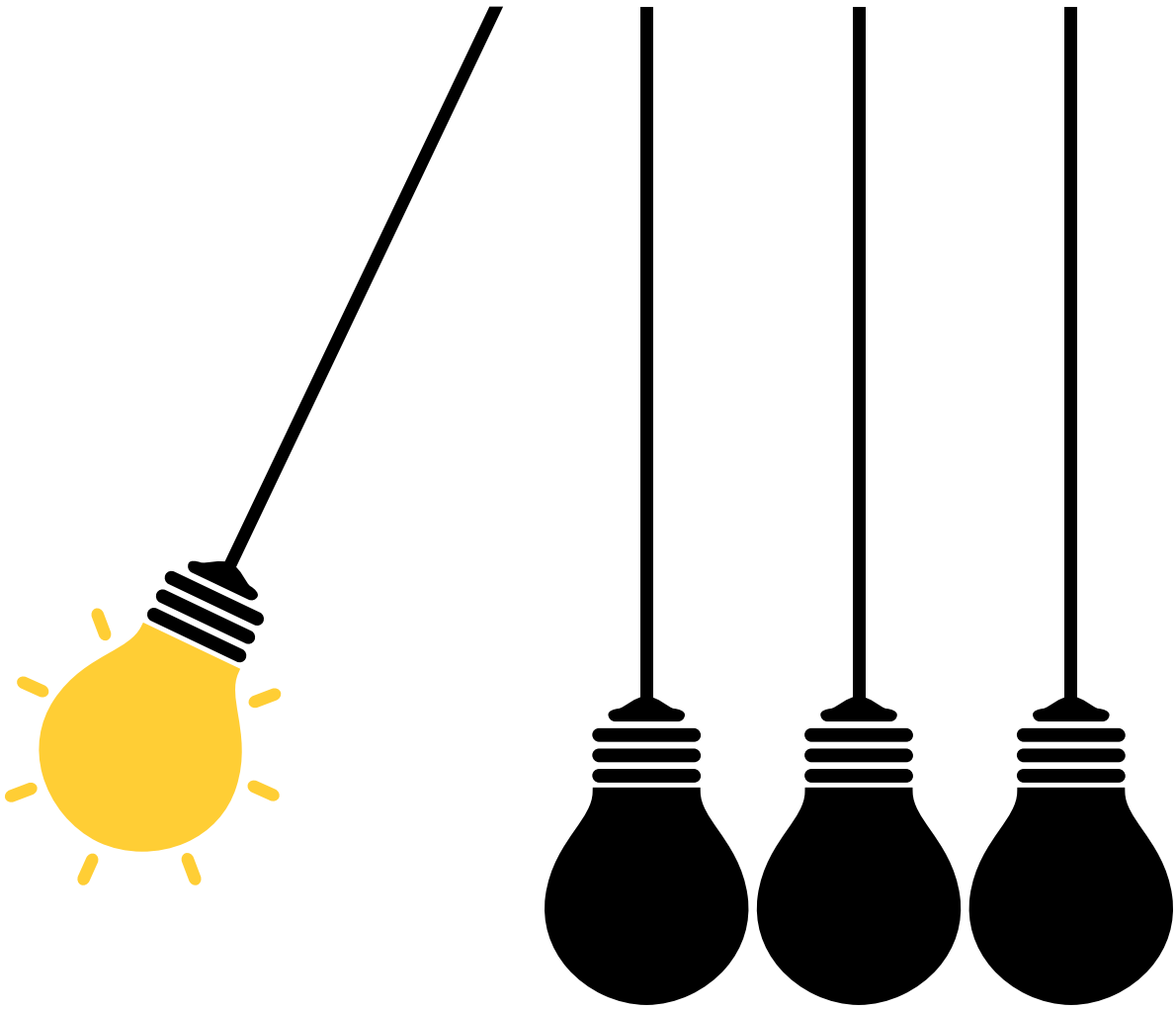
Within the next five years, the researchers hope to get closer to assembling the pieces that make up the complex picture of pediatric dysphagia and, in turn, uncovering new ways to prevent and treat the condition.

In the meantime, nearly two decades after Monica Jennings was diagnosed with DiGeorge syndrome, her mother's search for answers continues, as well. Years of medications, therapy and multiple surgeries have yet to resolve her daughter's difficulties with swallowing.

"I could go on for ages about the paths we have followed, plowed or dismissed, and the things we've discovered along the way," Lisa Jennings says.

New research endeavors give her hope, though she also understands better than most the challenges facing scientists. "I have an entirely different respect for the complexity of human biology," she says, "and just how fragile the body can be." GWR

One goal, he says, will be to create a "genetic map of vulnerabilities."



FUELING A CULTURE OF ENTREPRENEURSHIP

// By Mary A. Dempsey

Volker Sorger, a professor in the School of Engineering and Applied Science, talks of a deep canyon. On one side are people like him, working in labs on provocative research. On the other side is the commercial world where services and products are brought to market. The challenge, he says, is bridging that chasm.

Innovation Corps, or I-Corps, has begun building the bridge.

I-Corps, an entrepreneur-training program created by the National Science Foundation, is feeding GW's rapidly growing culture of entrepreneurship. It joins the annual GW Business Plan Competition [*see page 47*]; the GW Entrepreneurs Roundtable, an interdisciplinary group of faculty members, students, alumni and university administrators who organize activities and mentoring opportunities around entrepreneurship; and Pitch George, where GW graduate students, undergraduates and local high school students present their business ideas to judges for a chance to win seed money.

"I-Corps is the most comprehensive tool in that toolbox," says Jim Chung, the executive director of GW's Office of Entrepreneurship. "Professors and graduate students may be experts in their areas, such as cold plasma or a particular disease or a pathway to a drug, but they don't have business expertise," he says. "I-Corps is about how to get the invention out of the lab and into the real world."

The national program launched in 2011 for researchers who had past NSF grants. Two years later, NSF added seven "nodes," or regional programs that carry no previous agency-funding requirement. The nodes include DC I-Corps, an initiative that started with three universities: the George Washington University, Virginia Tech and the University of Maryland, and now includes Johns Hopkins University, as well. At GW, the DC I-Corps office is housed within the Office of Entrepreneurship.

The first of DC I-Corps' intensive boot camps was held in March 2014, hosting teams with projects as diverse as an autonomous sailing catamaran and a smartphone system that holds a patient's full medical history. Since then, the program has welcomed 17 more groups in sessions ranging in duration from two to six weeks, with more on the books.

> "I-Corps is about how to get the invention out of the lab and into the real world."
>
> JIM CHUNG, EXECUTIVE DIRECTOR OF GW'S OFFICE OF ENTREPRENEURSHIP

After boot camp, participants who want additional training can take advantage of a program, called an accelerator, that offers further coaching on building a business and commercialization.

"There has been a strong move with I-Corps to collaborate with other schools and the federal labs in the region, so a strength of the program is that we're engaged with people outside GW, such as Children's National Medical Center," says Dan Kunitz, a GW employee who is director of the DC I-Corps Accelerator. "We've had teams come in from Howard University and George Mason. And this is very rewarding."

DC I-Corps also recently hosted its first international boot camp, in Mexico City, in collaboration with Mexico's National Council of Science and Technology, known as CONACYT, and the United States-Mexico Foundation for Science, or FUMEC.

Mr. Kunitz says the node's location in Washington and its

Nanophotonics researcher Volker Sorger is among 20 GW faculty members who have completed both the national and regional I-Corps programs.

WILLIAM ATKINS

In May, **Jim Chung** was named to *Washingtonian* magazine's biannual list of "Tech Titans." Even by the standards of a rapidly evolving realm like technology, the magazine noted, in the past two years "the local scene has exploded, bringing deep reservoirs of talent to the region in an effort boosters hope will create a Silicon Valley on the Potomac."

access to embassies, international development agencies and other global entities is giving it a broad reach.

Mr. Chung says I-Corps is changing the way researchers think—and that carries a multiplier effect, because that shifting culture reaches students.

"We've had 20 professors go through both the national and regional programs—and even more graduate students and post-docs. That means we now have 20 professors who really understand the connection between their research and the market," he explains. "We don't want to lose them as researchers at GW, but we want to give them the understanding and methodology so they can apply it to their mentorship of students."

Dr. Sorger, the engineer, is one of those 20 professors. He says I-Corps approaches entrepreneurship in a dramatically new way.

"It used to be that you have an idea, you do a prototype, you alpha test and you beta test, you give it to people and you tweak it a bit," he says. "But we learned that didn't work, and making a prototype is an expensive way to fail."

In I-Corps, a team takes an idea at its early stage, asks the market what it wants and then decides if it can fulfill the need. Each DC I-Corps team consists of three members: an academic researcher, a student entrepreneur and a mentor or business expert.

Dr. Sorger cites a water quality technology he thought would be perfect for theme parks and cruise ships. "It turned out they already had things in place, plus they had regulations covering it," he says. "So then we thought maybe it would work for public drinking water, but we found there wasn't a big need.

"Then someone suggested we talk to the shellfish industry. Shellfish grow in coastal waters and when there is a storm, coastal waters can become contaminated," he says.

Dr. Sorger says that experience taught him not to be wedded to an idea. It also showed him that only through networking—since he knew nothing about the shellfish industry—could he understand the scope of the market. He says graduate students pick up the additional skills of public speaking and outreach, things they won't learn in the lab.

Serial entrepreneur Michael Keidar, the director of the GW Institute for Nanotechnology and the Micropropulsion and Nanotechnology Laboratory, is a repeat visitor to I-Corps. He has been through the national program and the D.C. boot camp with a project involving the use of plasma to manufacture graphene and a space propulsion initiative that NASA is currently testing.

The graphene project, which is patent pending, has been licensed to a small company. The space technology has been issued a patent, and Dr. Keidar is in talks with customers and investors.

"We learned a lot of things in terms of how to structure business and evaluate this particular idea," he says, adding that he followed up on the projects by entering the GW Business Plan Competition. "To a large extent, it involved thinking in a different way, to evaluate ideas from the beginning to see if there is potential in the market or if it is purely research."

Mr. Chung says his office has four missions: to foster innovation, to advance education, to help students and faculty launch business initiatives and to make connections among investors, researchers and entrepreneurs.

"I-Corps fits under all those rubrics," he says.

WILLIAM ATKINS

Elizabeth Phillips and Romil Patel present their concept, BleedFreeze, during the GW Business Plan Competition.

WILLIAM ATKINS

A NATURAL CONNECTION

As she creates a limited liability company for her innovation—a device to stop nosebleeds—Elizabeth Phillips, an emergency room resident at GW Hospital, is tapping as many university resources as she can. So far that has meant Pitch George, the GW Business Plan Competition, where her team won honorable mention this spring, and DC I-Corps.

"My team was in the accelerated two-week I-Corps boot camp and in the business plan competition at the same time. Plus I was working," says Dr. Phillips. "I was not sleeping in February."

Dr. Phillips says the team is now eying another tool in the entrepreneurial kit: the national I-Corps program.

Lex McCusker, director of the GW Business Plan Competition, says there is a natural interplay between I-Corps and the business plan contest.

"We have adopted many of the essential components of I-Corps and use them in scoring, coaching and mentoring for the student teams," he explains. "One of the things we're also seeing is that the teams that do the best are the teams that come from complementary disciplines, teams that, for example, combine the School of Engineering, the Elliott School and the School of Business.

"That is a byproduct of I-Corps," says Dr. McCusker. "I-Corps forces the creation of cross-disciplinary teams."

Dr. Phillips came up with the idea for BleedFreeze after treating small children and senior citizens who turned up in the emergency room with nosebleeds. Because these two groups had trouble keeping pressure applied to stop the bleeding, the ER staff would jury-rig devices using tongue depressors and tape.

After inventing a clip that combines cooling and compression, Dr. Phillips formed a business team with Romil Patel, a senior in the Department of Biomedical Engineering, and School of Medicine and Health Sciences faculty members Hamid Shokoohi and Neal Sikka, both in the Department of Emergency Medicine.

"Our team is physicians and engineers so we're weak on the business side," Dr. Phillips says. "The DC I-Corps process allowed us to do over 30 customer interviews to help us pivot on our design. We also made a lot of good contacts."

With the national I-Corps program, not only would the team deepen the advances made in the D.C. boot camp but it would open the door to NSF funding. BleedFreeze has a provisional patent, and the team is working on a prototype of the device.

BleedFreeze is one of two GW Business Plan honorable mention winners in 2015 that arrived with I-Corps credentials. The other is GutFeeling, a subscription-based service for monitoring digestive health. Krista Smith, MS '13, a member of the GutFeeling team, says the service holds particular value for people with allergies, chronic stomach problems, autoimmune ailments or those trying to lose weight.

And this spring, the GutFeeling team won a spot in the national I-Corps summer session.

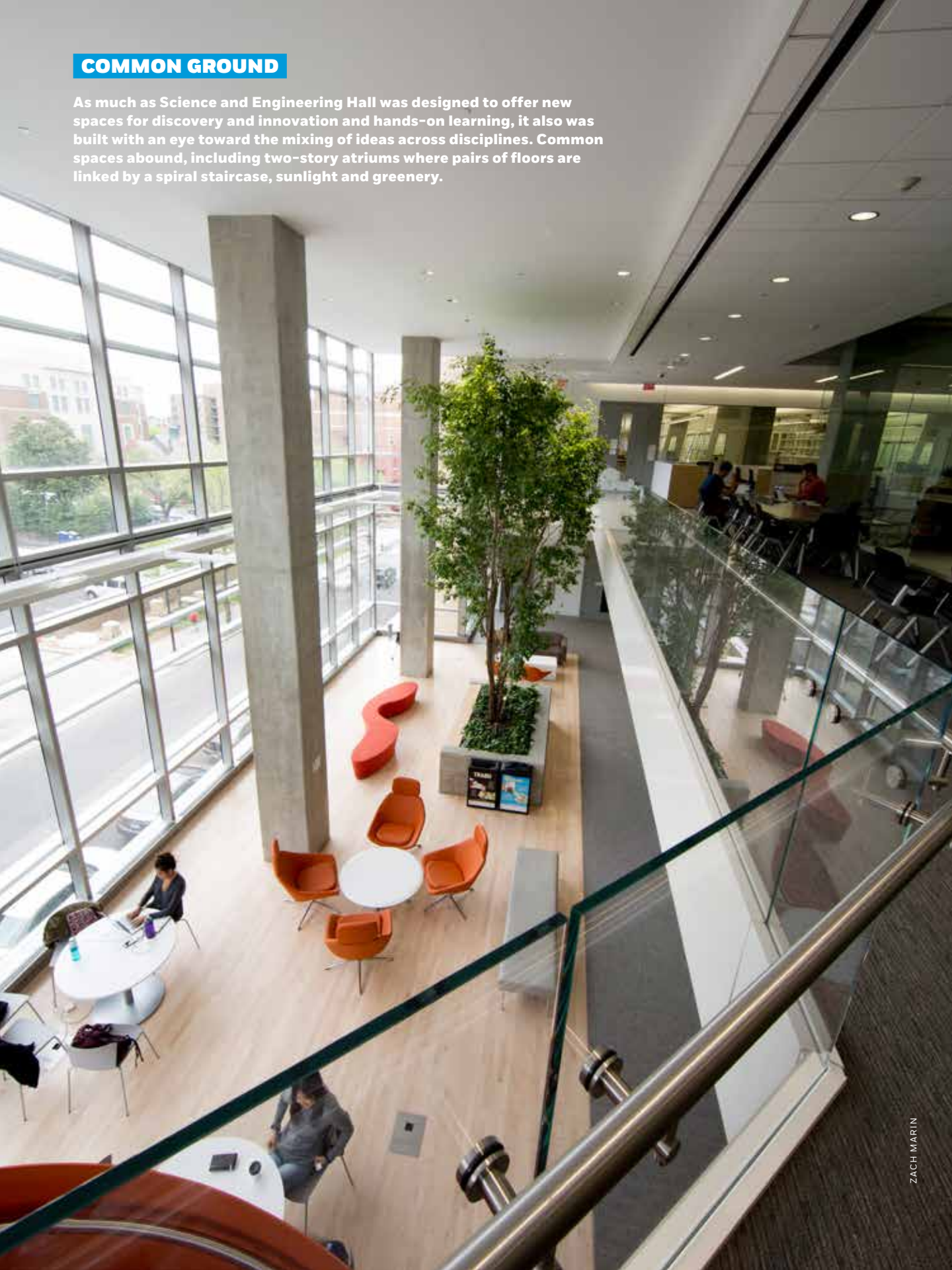
Since the launch of the GW Business Plan Competition in 2009, when 10 teams competed for $30,000 in prizes, it has evolved into one of the country's 10 largest contests. This April, 105 teams vied for more than $117,000 in cash prizes and $92,000 in in-kind prizes, such as office space and business services.

Benjamin Holmes, a GW doctoral student in mechanical engineering, also formed a business team, along with engineering professor Grace Zhang and mentor Matthew Scherer, BBA '76, that went through the seven-week DC I-Corps boot camp with a biomedical project involving 3-D technology for joint repair.

Mr. Scherer, a partner at Connecticut-based Rockland Advisory Group who serves as a mentor for I-Corps and business plan teams, says I-Corps changes the entrepreneurial culture. It asks that researchers look beyond whether something can be done and determine "if it's also something that people might need and whether investors will put funds into the project."

COMMON GROUND

As much as Science and Engineering Hall was designed to offer new spaces for discovery and innovation and hands-on learning, it also was built with an eye toward the mixing of ideas across disciplines. Common spaces abound, including two-story atriums where pairs of floors are linked by a spiral staircase, sunlight and greenery.



ZACH MARIN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