Breathe. Feel the deep pinch of pure cold.

With temperatures in Antarctica sometimes sinking to minus 110˚F, the southern continent can be as frigid as the surface of Mars.

But that icy austral air has much to tell science.

Last October, a team of Drexel researchers led by Peter DeCarlo, an assistant professor in the Department of Civil, Architectural and Environmental Engineering and the Department of Chemistry, traveled to Antarctica on a mission funded by the National Science Foundation. They spent weeks collecting air samples that will help scientists worldwide better understand the polar atmospheric chemistry and its links to the ice core record and ozone depletion.

Using sensitive, high-resolution sampling instruments never before deployed in Antarctica, they amassed one of the largest and most detailed datasets of the continent’s airborne particles ever assembled. Their instruments detailed particle size and composition and collected general atmospheric readings for analyzing the interplay between particles, wind, sun and trace gases such as ozone gases — in particular, the team sought to investigate a negative correlation between ozone totals and particle size.

After a second trip planned for late 2015 and the completion of their study, the team will have millions of data points that will become publicly available to anyone interested in studying the Antarctic atmosphere.

The only way to reach Antarctica is through an unprepossessing terminal at the Christchurch International Airport in New Zealand. Through it flow researchers and support workers from around the world headed for McMurdo Station, the U.S. base in Antarctica that serves as the gateway to much of the continent. Before boarding, passengers are required to prepare for the 6.5-hour flight by suiting up in special cold-weather gear. Goggles, check. Balaclava, check. Your choice between mittens and gloves.

Flights to McMurdo are aboard massive Boeing C-17 military cargo planes contracted through Lockheed Martin by the National Science Foundation. Uniformed Air Force personnel serve as the cabin crew, and passengers ride inside a hold designed to haul cargo as large as Army tanks. Early in the season, seats are removed from the plane’s interior to make room for storage pallets filled with fresh food and supplies for the station. Later in the season, passengers outnumber cargo. On this particular flight, Drexel researchers were one of about 10 research teams heading to the station at the start of its spring/summer season to perform research projects that can only be done in the unique Antarctic environment.
WEATHER_PERMITTING
Flights into and out of Antarctica are scheduled every two days, but sometimes entire weeks pass without a visit. Visibility vanishes perilously when the wind picks up and blows snow across Pegasus Field, a year-round landing strip on top of a blue ice shelf about an hour from McMurdo Station. Blue ice areas are known for having little snow accumulation, which makes them safe for wheeled (rather than ski) landings.

Researchers at the station are able to leave McMurdo only when the weather permits. All travel is banned under “Condition 1.” Under “Condition 2,” travel off-base is restricted to enclosed vehicles. Under “Condition 3,” researchers are free to travel outdoors and flights continue as scheduled.

LONESOME_LAB
McMurdo Station is like a small frontier town — remote and self-reliant. It boasts about 1,000 residents during the summer peak and a skeleton crew of about 250 who “winter over.” Researchers make up about a quarter of the population; the rest are mechanics, pilots, carpenters, cooks and other support staff. Owned by the United States and operated by the National Science Foundation, it is the largest of 30 research stations run by various governments on the continent, which is shared by international treaty. More than 100 permanent buildings have been erected at the station — a long way from the historic huts that mark the base’s first settlement — and they include dormitories, medical buildings, dining hall, firehouse, water distillation plant and power generator. Reputedly, some of the best views are from a dormitory lounge, where during the summer months the sun remains suspended above the horizon in a perpetual sunset.
LOST_HIGHWAYS
Snowmobiles are the preferred mode of transportation in Antarctica. Lighter and faster than the large transporters known as PistenBullys, snowmobiles can cover in 30 minutes the same distance that takes a PistenBully two hours — perfect for scouting for a research base on the ice shelf of McMurdo Sound. Researchers chose a site about 19 miles from McMurdo Station, on top of six feet of sea ice, where winds bring air particles in both from land and sea. They marked their route out onto the ice with flags every 50 to 100 meters so that when visibility turned poor, they could find their way back to McMurdo.
A small fishing hut contained everything the team needed to conduct their research. Positioned on top of skis, the hut was hauled out onto the ice by large bulldozers and powered during the study by two diesel generators. As cold as it was outside, the equipment sometimes heated the tiny space to 90°F, forcing the team to install remotely controlled fans to cool down the instruments. Antenna on the roof brought spotty Internet service via satellites, keeping the hut’s control panels connected to the team back at McMurdo Station, if only intermittently. From there, the team could monitor instrument readings as they poured in every few minutes, 24 hours a day, for five weeks.

THE SIX
The research team, at McMurdo Station (from left): Peter DeCarlo, co-principal investigator and assistant professor in Drexel’s Department of Civil, Architectural and Environmental Engineering and Department of Chemistry; Anita Johnson, graduate student in Drexel’s Department of Civil, Architectural and Environmental Engineering; Sean Davis, research scientist with the National Oceanic and Atmospheric Administration and the Cooperative Institute for Research in Environmental Science, University of Colorado; Lars Kalnajs, co-principal investigator and atmospheric scientist at the University of Colorado’s Laboratory for Atmospheric and Space Physics in Boulder; Terry Deschler, professor emeritus at the University of Wyoming’s Department of Atmospheric Science; and Michael Giordano, postdoctoral researcher in the Department of Civil, Architectural and Environmental Engineering at Drexel.

ROOM WITH A VIEW
Visit exelmagazine.org to experience what it’s like to be in Antarctica through time-lapse videos and stunning 3-D photographs.
DATA CENTER
The team’s research hut contained about $1 million worth of sensitive air monitoring equipment. Collectively, the instruments and the data they recorded represent a significant leap forward in time resolution and sensitivity compared with existing studies on Antarctic air particles.

01 The Aerosol Mass Spectrometer measures minute-by-minute changes in the chemical composition and size of particles in the air smaller than 1 micrometer — or less than 1/100th the diameter of a hair. It is used by researchers all over the world as a powerful method for measuring submicron particle composition, size and concentration — but never before has the instrument been used in Antarctica. Most existing measurements of particle composition in Antarctica have been made using filter and impactor particle collection and off-line chemical analysis of samples. But these tools have limits. Filter collections and off-line analysis take a long time (days as opposed to minutes) to collect sufficient concentrations of particles, which can introduce sampling artifacts, and they have limited size distributions.

02 Filter collections (not visible in this photo) were used to verify that the spectrometer was getting correct readings.

03 Another device used for verification was the Scanning Electrical Mobility Sizer. It uses radioactive polonium to give particles a charge, which then enables the device to determine particle size distribution in the atmosphere from 20 nanometers to 1 micrometer.

04 This box contains an ultra-high sensitivity aerosol spectrometer that sizes particles optically using lasers.

05 The Particle Into Liquid (PILS) Sampler is a prototype of a new design that was being used in extreme cold for the first time on this trip. This is the only instrument on the trip other than the filters that can be used to measure particle composition.

06 The gas phase instrument measures ozone (O\textsubscript{3}) and NO\textsubscript{x} (nitrogen dioxide, NO\textsubscript{2}, and nitrogen monoxide, NO) in the atmosphere. The team brought this along because when sun shines on snowpack at low wind speeds, the snow releases NO\textsubscript{x} through photolysis. The team detected a strong pattern of NO\textsubscript{x} increasing during daylight hours.
GAIT KEEPERS
Drexel scientists and clinicians in the College of Nursing and Health Professions are making sure that research on running injuries and advancements in rehabilitation keep up with the popularity of the sport.
by Katie Clark

BUILDING A BETTER POWER PLANT
A group of academics is testing a radical new way of cooling thermoelectric plants that could reduce the power grid’s dependence on freshwater.
by Mike Unger

GIANT FROM PATAGONIA
Discovered a decade ago and preserved in secrecy until just last year, the record-setting new dinosaur species Dreadnoughtus schrani is informing the way scientists think about the largest animals to ever walk the surface of the Earth.
by Rachel Ewing

NEW SPECIES, DANGERS OF CLEANING AEROSOLS, URBAN ECOLOGY, WATER ALLIANCE, GYANANDROMORPH BUTTERFLY, ENERGY AND ENVIRONMENT INSTITUTE, PARASITIC RELATIONSHIPS, MYSTERY FISH
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Hiding in the feathers of the birds of the Earth, there is a whole other world just waiting to be unruffled.
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Jennifer Taylor was researching firefighter injuries when she discovered an alarming number of assaults by patients against paramedics and EMTs. Now she’s building a case for policy changes to protect medics from physical and psychological job hazards.
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INVENTED HERE
Drexel is one of only a handful of research universities endowed by the Coulter Foundation to bring promising academic inventions to the marketplace.
by Lini S. Kadaba
It’s been the year of the dinosaur at Drexel. From National Geographic to CNN to an NPR quiz show, media outlets around the world rushed to report on Dreadnoughtus schrani, the new supermassive dinosaur species described for the first time by Drexel paleontologist Ken Lacovara and his team.

Few subjects invoke the joy of scientific discovery more reliably than dinosaurs. In fact, you’re probably itching to flip ahead and read about Ken’s work right now — but first, I want to draw your attention to some research aimed at making sure we don’t go the way of the dinosaurs.

Drexel scientists are changing how we understand and protect our environment. They can be found in Antarctica, where Peter DeCarlo uses spectrometry equipment he helped design to learn about the composition of aerosol particles in one of the world’s most pristine environments, and at the local thermoelectric plant, which may someday use far less fresh water thanks to a College of Engineering team’s research into “dry cooling” technologies.

Right here in the mid-Atlantic region, the Delaware River Watershed Initiative uses protocols developed by the Academy of Natural Sciences of Drexel University to sample water quality at more than 300 sites. In fact the initiative, a collaboration of 50-plus institutions brought together by the William Penn Foundation, draws on Academy scientists for a wide range of expertise to help protect the Delaware River Basin, a critical source of drinking water for more than 15 million people. That’s exactly the sort of impact on real-world environmental challenges that we envisioned when the Academy and Drexel joined forces in 2011.

I hope you enjoy this issue of EXEL, and I thank you for taking the time to learn more about the vital and wide-ranging research enterprise at Drexel.

John A. Fry / President
AMONG THE HIGHLIGHTS FROM THIS ISSUE

1. Explore the icy beauty of Antarctica’s frozen terrain through stunning 3-D images and time-lapse videos.

2. Visit the excavation site in Patagonia where a new supermassive dinosaur was discovered, hear from paleontologist Ken Lacovara about what this great beast looked like in life, and check out 3-D scans of the creature’s bones, which make it easier for scientists to study them without all the heavy lifting.

3. Follow along as one Drexel researcher takes data from a computer and 3-D prints a customized heart model to help doctors and patients communicate better.

4. Watch a video animation of the internal bony structure of a mysterious catfish that defies classification.

5. See up-close Drexel’s 3-D printer at work, a tool Drexel researchers are using to take cancer cells out of the petri dish.

EXPLORE EXEL ONLINE

Connect with EXEL Magazine on the Web for online-only exclusive content, interviews with Drexel researchers, more in-depth coverage and videos about our work, updates from our growing research enterprise and more. Visit exelmagazine.org.
Pramod Abichandani was wrong. He can’t build a programmable instructional robot that retails for $25. Yet.

But that’s the goal the Drexel University senior researcher and assistant teaching professor set for himself at a September 2012 session of Senior Design, the capstone program for Drexel’s College of Engineering.

In a room full of mostly fifth-year electrical and computer engineering students, Abichandani made the case for a low-cost teaching aid that would give kindergartners and grade school children a chance to apply math, physics, mechanics and electrical engineering to set their devices in motion.

In his vision, the device would introduce young children to the fields of programming and robotics and prepare them to succeed in STEM jobs. It would be cheaper than educational robotics kits currently on the market. It would be approachable. Cute, even.

He’s spent the past two years edging closer to making his idea a reality. With prototypes in hand, he’s spun out an education technology nonprofit and won a spot in DreamIt Ventures, a celebrated tech startup accelerator program headquartered in the Innovation Center @3401 in Philadelphia that he hopes can help him eventually mass produce the devices.

His current prototype is a compact, softball-sized gadget with two wheels and two antennae. Using a mobile app, children can live control the robot’s movements, much like a toy car. They can also pre-program the robot’s movement, ordering different programming blocks that control its direction, its pauses, its responses to obstacles and more. From there, advanced users can visit the LocoRobo Academy, an online web portal with lessons and additional curriculum connecting how they played with how the device works.

“That’s the beginning of coding,” says Abichandani.

Ultimately, Abichandani discovered he couldn’t create a device for under $25 without giving up important features: Web connectivity, an accelerometer for precise velocity, a gyroscope for orientation, and a robust mechanical design that can handle the wear and tear of children. But he believes that he can create a model for something in the neighborhood of $99 per unit.

That’s less than one of the most popular educational robots on the market, which is produced by the LEGO brand. LEGO’s Mindstorms product line features programmable robots such as the EV3, which sells for $350.

Abichandani’s devices are not only less expensive, they’re also built on open source software packaged with tested and validated learning principles to help young students learn.

While he continues to fine-tune the device mechanically, he’s working with local teachers to build more instructional materials around LocoRobo.

Green Woods Charter School in Philadelphia will be part of the first pilot for LocoRobo and its STEM-friendly curriculum.

“The program is designed to grow with the student; there really isn’t anything on the market that uses that principle,” says Ryan Ragland, a seventh-grade teacher at Green Woods Charter School who helps to organize the school’s robotics club with Addison Lilholt, a science teacher.

“The more kids play, the more they learn,” says Lilholt.
Youth robotics programs are a popular way to teach children STEM skills — where jobs are growing fastest and salaries have an average premium of 26 percent. In his State of the Union speech this year, President Obama warned that the United States needs to produce more skilled workers to fill the 1.2 million STEM jobs available in coming years.

“The program is designed to grow with the student; there really isn't anything on the market that uses that principle.”

—Ryan Ragland, seventh-grade teacher at Green Woods Charter School
A conductive clay can be rolled to any thickness and shows promise in energy storage devices such as batteries and supercapacitors.

A new clay discovered by materials scientists in the College of Engineering’s Department of Materials Science and Engineering may take the lead in the race to find materials of ever-increasing thinness, surface area and conductivity for better-performing battery electrodes.

The clay, which exhibits conductivity on par with that of metals and can easily be molded into a variety of shapes and sizes, represents a turn away from the rather complicated and costly processing currently used to make materials for lithium-ion batteries and supercapacitors.

With the publication of their recipe for “conductive MXene clay” in Nature, the researchers have a formula for turning the clay into a film — usable in an electrode — simply by rolling or pressing it. The process is quick, simple and uses common ingredients.

The clay is one of the latest ways researchers are discovering new iterations of MXenes — two-dimensional materials discovered at Drexel that could be used in next-generation batteries and supercapacitors.

At 900 F/cm³, the clay shows a higher capacitance per unit of volume than most other materials, and it does not lose any of its capacitance through more than 10,000 charge/discharge cycles.

“Both the physical properties of the clay, consisting of two-dimensional titanium carbide particles, as well as its performance characteristics, seem to make it an exceptionally viable candidate for use in energy storage devices,” says Yury Gogotsi, who is a co-author of the paper and a distinguished university and trustee chair professor.

“While it might look like just a bit of clay, I believe this discovery will reshape research in many fields going forward,” says Michel Barsoum, a distinguished professor in the department and one of the discoverers of MXenes.

The discovery came about while Michael Ghidiu, a doctoral student advised by Gogotsi and Barsoum, was testing a new method for making MXenes.

Straying slightly from the original chemical etching process pioneered at Drexel, which uses highly toxic hydrofluoric acid, Ghidiu instead used a fluoride salt and hydrochloric acid to etch aluminum out of a titanium-based, layered ceramic material called a MAX phase — also discovered at Drexel by Barsoum. These two ingredients reduced the MAX phase to a pile of black particles.

To stop the reaction and remove any residual chemicals, Ghidiu washed the material in water. But rather than finding the familiar layered MXene particles, he discovered that the etched sediment absorbed the water to form a clay-like material.

“We were just hoping for a safer, less expensive way to make MXenes, when something even better landed on the table,” Ghidiu says.

Researchers have chemically engineered a new, electrically conductive nanomaterial that is built of layers just a few atoms thick and is flexible enough to fold but strong enough to support many times its own weight.

They believe the film can be used to improve electrical energy storage, water filtration and radio frequency shielding in technology from portable electronics to coaxial cables.

This material is the latest expression of the ongoing research on a family of two-dimensional materials called MXenes, which were discovered at Drexel in 2011.

This development was facilitated by collaboration between Drexel’s Yury Gogotsi and Michel Barsoum, with Jieshan Qiu, vice dean for research of the School of Chemical Engineering at Dalian University of Technology in China.

To produce the flexible conductive polymer nanocomposite, researchers intercalated the titanium carbide MXene, with polyvinyl alcohol — a polymer widely used as the paper adhesive known as Elmer’s glue. They also intercalated with a polymer called PDDA (polydiallyldimethylammonium chloride) commonly
**A HAND ON YOUR HEART**

What if you could **hold your own heart in the palm of your hand** and study it while your cardiologist explained your condition?

**I**mage running your finger along the squiggly pattern of the worm-like coronary artery, or poking around the inside of each of the heart’s four chambers, feeling for abnormalities. It’s your heart, after all. Get a good look.

Most visual representations of a patient’s heart — based on X-rays, drawings, CT imaging and computer animation — never move beyond two dimensions. But Jason Kirk, an adjunct professor of digital media, found a way to create a useful medical tool that bridges the knowledge gap between doctor and patient.

“We have this complex organ that is essential to life, and if something goes wrong, we’ve got one person who can fix it and one person who can let them,” Kirk says. “Can we use this tool to get those people on the same page as quickly as possible?”

While on co-op in 2009, Kirk discovered 3-D printing, and was hooked. First he began making jewelry. Then, he experimented with toys and game pieces. Not long after, a few Drexel faculty and mentors challenged Kirk to use his skills for something bigger.

Kirk dug deep and harkened back to age 15, when he was in a doctor’s office with his father, who had suffered an aneurysm.

“The doctor showed us CT data, and I wouldn’t know it from Egyptian hieroglyphs,” Kirk says. “I thought back to that and realized there is a huge gap there.”

So Kirk, then a graduate student and with no medical background, set about trying to make a 3-D, patient-specific replica to help patients understand pathology and discuss treatment.

“This model can provide patients with easily digestible information so they are well informed and can make the best decisions for the care they need to manage their illness,” Kirk says.

**I_HEART_3-D**

To create a 3-D heart, Kirk used a software program called Mimics. He transferred 2-D CT data from the computer to an industrial-strength 3-D printer and created a realistic and detailed anatomic model of an anonymous individual’s heart, which can be sliced down the middle to provide for interior views.

**3-D PRINTED TUMORS**

An engineering breakthrough will allow cancer researchers to **create living tumors with a 3-D printer**.

**Drexel researcher has de**

vised a method for 3-D printing tumors that could take cancer research out of the petri dish.

Using a mixture of cervical cancer cells and a hydrogel substance, Wei Sun can print out a tumor model that provides a more accurate way to study how tumors behave and respond to treatment.

Sun is the Albert Soffa chair professor in the College of Engineering.

While researchers have been able to make cell models and tissues using rapid prototyping methods for some time, Sun’s lab is the first to produce a living tumor model using 3-D printing. The procedure was described in Biofabrication in 2014.

For cancer researchers, 2-D samples have inherent limits. Tumors in the body have a much different surface area, shape and cellular composition than samples grown in a lab, thus data from tests of cancer treatments will differ from the reaction of an actual tumor to the drugs. But until now, in vitro cell cultures were their best option.

“Three-D tumor models can represent true tumor 3-D pathological organizations,” Sun says.

Sun tested his tumor model against a two-dimensional culture sample using a common anti-cancer drug.

For the undertaking, Sun’s team used a multi-nozzle printer of his own design to extrude a gelatinous mixture of hydrogels and living cervical cancer cells. Ninety percent of the cancer cells survived the process and within eight days had grown into spheroid-shaped tumors.

The 3-D printed tumors showed more resistance to chemical treatment than the same cancer cells from a petri dish — an illustration of the disparity between test results and success rates of cancer treatments.
Though there have been efforts to revive the rusting remains of the SS United States luxury liner as a hotel or casino, it is unlikely that the public will ever again tour its interior — until now.

During her heyday in the ‘50s and ‘60s, the giant passenger ship SS United States was the pinnacle of luxury ocean travel — setting records for top transatlantic crossing speed.

The 900-foot, seven-story nautical titan was decommissioned in 1969 and eventually came to rest in 1996 at Pier 82 in South Philadelphia, where its hull has been slowly rusting ever since.

But thanks to a team of Drexel digital media students — Zach Stockmal, Justin Wu, Tom Welker, Chris Elliott, John Novak, James Maguire and Jessie Wu — and their advisor, Westphal Associate Professor Glen Muschio, anyone can now tour the ship digitally — until now.

They’ve produced an interactive, three-dimensional digital model of the icon.

For guidance, the group used historical reference material including an original floor plan provided by the SS United States Conservancy, the group that maintains the ship, and online resources including old photos, videos and postcards.

The biggest challenge lay in recreating the environment onboard, especially interior lighting.

“The promenade and outer rooms had natural light through the windows, but you couldn’t really tell from the pictures how the light got to an interior room like the Navajo Lounge, and that affects the shadows, the colors and textures of the paintings, everything,” says Stockmal.

To answer this question, the group got a rare opportunity to spend two hours on the promenade deck.

They then plugged their models into a game engine to create a lifelike virtual experience. The tour features a dozen stops including the Navajo Lounge, the observation lounge, the promenade, the first-class smoking lounge and two of the ship’s theaters.

A team of computer scientists led by researchers from Drexel University’s College of Computing & Informatics has devised a way to lift the veil of anonymity protecting cybercriminals by turning their malicious code against them.

Their method uses a parsing program to break down lines of code, like an English teacher diagramming a sentence, and then another program captures distinctive patterns that can be used to identify its author.

“Just like writers and artists, every coder has a unique style all their own,” says Aylin Caliskan-Islam, a doctoral student at Drexel who developed the system and is the lead author of a paper on the topic. “Our process distills the most important characteristics of a programmer’s style — which is the first step toward identifying anonymous authors, tracking cybercriminals and settling intellectual property questions.”

Caliskan-Islam drew on contributions from Princeton University, the University of Maryland, the University of Göttingen in Germany, and the Army Research Laboratory to produce a digital analytics system that could become a kit for electronically “fingerprinting” cybercriminals.

Caliskan-Islam’s team tested their theory using acquired volumes of code — the collective work of 250 contestants who solved coding challenges as part of “Google Code Jam” competitions from 2008–2014. This sample yielded 20,000 distinct coding features and Caliskan-Islam’s program narrowed that list down to the most relevant 137, which were used as the data points for generating digital fingerprints for the authors.

When the team put together a lineup of anonymous author “suspects” to see if the program could successfully match them to some of their code, it was able to pair the code and its author with 98 percent accuracy — marks nearly as high as modern fingerprint analysis.
_HOLDING OUT HOPE

A soft, robotic exoskeleton glove developed at Drexel could hold the key to new ways of restoring function to individuals with hand injuries.

When Michael Koerner ’17, a third-year biomedical engineering student, developed a haptic glove as part of a freshman engineering design contest two years ago, he hoped the glove could help people who have lost their ability to grip.

It didn’t take long for the Exo-Skin, as Koerner calls the glove, to attract the attention of professors in other disciplines, who saw its potential in digital data manipulation and hand therapies.

Andrew Cohen, an associate professor of electrical and computer engineering in the College of Engineering, initially imagined using the glove to improve human interaction with 3-D microscopy images for better measurement of how stem cells develop in living brain tissue.

To make new prototypes, they turned to Genevieve Dion, an associate professor of fashion design. Dion is also the director of the Drexel Shima Seiki Haute Technology Lab, which operates high-tech industrial knitting machines capable of fabricating garments with smart yarns.

Dion’s expertise made mass-producing the device a distinct possibility.

The next evolution in the glove’s design came when Jane Fedorczyk, a physical therapist who is board certified in hand therapy and a clinical professor in Drexel’s College of Nursing and Health Professions, saw the glove.

“My first comment to another certified hand therapist was, ‘I saw this research project today that could transform the way we do hand rehabilitation,’” recalls Fedorczyk.

Actuators in the glove pull or release tendon-like cables that run from the wrist to the fingertips, exerting force on the fingers.

The glove is connected to a computer and Koerner and Cohen are perfecting a program that monitors movements and biometrics. Fedorczyk believes the glove could help patients with hand injuries by allowing them to practice normal movements. Since the glove’s tendons are attached to motors, they can provide resistance for exercises and even be programmed to move a person’s fingers.

“Some patients are unable to move actively to achieve full mobility,” Fedorczyk says. “They may stop because of pain or swelling. They stop because their fingers are stiff and they don’t think they can go any further. But the reality is, the resistance that’s built into the actuators, they get feedback to see they can go further.”

Fedorczyk will test the glove’s feasibility with patients in the fall.
tion’s power needs, and it won’t be the last. As increased development — particularly in the west and southwest — gobbles up precious water resources and warming trends raise temperatures above historical norms, the country’s reliance on water to generate power is increasingly risky.

One solution is dry cooling technology, which uses air instead of water to cool steam condensers inside power plants. No water is wasted, and no fish are threatened.

Although relatively common overseas, dry cooling is used in less than 1 percent of U.S. thermoelectric plants. That’s because dry-cooled power generation is 10 percent less efficient on hot days and is up to five times more expensive to build than more common designs, explains Jessica Shi, senior technical leader/manager, technology innovation research for water conservation at the Electric Power Research Institute (EPRI), an energy industry research outfit.

But what if there were a better design?

A DRY RUN

That was the question posed by the National Science Foundation and EPRI in 2013, when they teamed up to offer a grand challenge to inspire researchers to propose new, transformative cooling concepts.

In Drexel’s College of Engineering, three mechanical engineering and mechanics professors were intrigued by the challenge. Associate Professor Ying Sun, Assistant Professor Matthew McCarthy and Professor Young Cho chalked up some ideas.

“We weren’t allowed to use water, the design had to be at least three times more efficient at heat transfer, and it had to be cost effective,” says Sun, the project’s principal investigator.

After a month, they had about 10 ideas. Most had some fundamental flaw — the systems would have to be too big, or too unreliable, or too expensive.

But one seemed promising, and it was fairly simple from an engineering standpoint. Instead of water, use paraffin. Instead of large metal condensers to cool the paraffin, spray it into the air.

Paraffin is a colorless, soft wax derived from petroleum. It’s similar to candle wax but has a lower melting temperature, which makes it ideal as a phase-change material (a material capable of storing and releasing heat as it changes form, as water does so perfectly) because it easily converts from liquid to solid, and back again.

It’s also nontoxic, readily available and cheap.

“Cost is really important because water is 1 cent per ton — it’s basically free apart from the cost of pumping it — and alternative heat transfer materials are very expensive,” says Sun. “Paraffin is about $1,000 a ton, so it’s affordable, and it’s a classic, stable, proven material.”

The team — which also includes Assistant Research Professor Philipp Boettcher from mechanical engineering as well as a post-doctoral researcher and graduate and undergraduate students — then tackled the problem of how to design a condenser that would convert heated paraffin
back to solid form. There were obvious disadvantages to adopting the fin-tube system common in the industry.

“Existing dry cooling technology uses metal fins to convert steam back into water — it’s like the radiator in your car, it has a lot of fins to create a large surface area. However, the effectiveness of the heat transfer of the fins is very low,” says Sun. “It’s also expensive. The dry cooling condenser for a typical 500 megawatt plant costs $100 million because you have to use many ribbons of sheet metal in the fins.”

Instead, they looked to the cooling tower concept already used in some plants, which sprays heated water from the condenser into the tops of open towers. Whatever doesn’t evaporate collects at the bottom as cooled water ready to be discharged. Unlike water, which partially evaporates when it’s sprayed into the air, the paraffin will solidify and can then be collected and used again for another cycle.

“We’re taking the primary steam coming off of the power plant and we’re running a series of tubes through a big bath containing a liquid version of this wax, then we’re taking this wax and spraying it up in the air,” McCarthy explains. “We have these little tiny droplets of wax that have very high surface area. You have millions of droplets. When you take a certain volume of something and chop it up into a million small units, you create a huge amount of surface area.”

The droplet approach improves the effectiveness of heat transfer by a factor of four, well within the range required of the grand challenge, says Sun.

For inspiration, the team looked to simple ideas already in existence. To understand how wax behaves as a spray, for instance, they watched YouTube videos of apples being treated with protective fruit wax coatings before heading to supermarkets. And on a summer vacation to the amusement park Dutch Wonderland in Lancaster, Pennsylvania, Sun bought her young son a Dippin’ Dots Ice Cream treat — a snack created by flash-freezing ice cream droplets.

Their wax-and-spray-cool concept won over the National Science Foundation and EPRI, which jointly awarded the professors and their team a $1 million grant last year to continue the research.

Their next step was to evaluate how well their concept would work in a real system. They used some of the money from their initial grant to work collaboratively with Advanced Cooling Technologies, a thermal management engineering company in Lancaster, Pennsylvania, to construct a 5-kilowatt prototype (a plant is usually at least 500 megawatts) and filed a patent on the idea.

They’re now conducting tests to better pinpoint how energy-efficient the design could be.

“Cost is really important because water is 1 cent per ton — it’s basically free apart from the cost of pumping it.”

“Cost is really important because water is 1 cent per ton — it’s basically free apart from the cost of pumping it.”

“To design the final system, we need to more accurately understand the solidifying and melting processes that these waxes are experiencing,” says McCarthy. “Liquid wax droplets are solidifying as we blow cold air over them, and solid wax particles are melting in a slurry moving past the hot steam tubes. These are the two phase-change processes that we need to characterize.”

The team has built a series of experiments for the prototype that will allow them to measure the heat transfer coefficient as solid wax particles fall into liquid wax and float through a series of heated tubes that simulate the steam in a typical thermoelectric system. The experiments will tell the team how long it takes the particles to flow through the system and at what rate they’re melting.

“We’ll come up with correlations to predict their performance, and we can use those models to design a full system,” says McCarthy. Meanwhile, a consulting company, Worley Parsons in Reading, Pennsylvania, is conducting economic feasibility studies on their design.

**DRY COUNTRIES**

By 2025, lack of water availability is projected to constrain thermoelectric power plants in many areas of the country.

[Map of Dry Counties]

Source: Congressional Research Service.
GETTING REAL
Skepticism about the team’s system, which in a perfect world wouldn’t even be able to be implemented on a full scale for at least five years, abounds among experts, McCarthy admits.

“There are plenty of people in the power plant industry who think this is a pretty radical idea,” he says. “But academics kind of blur the line between science and science fiction. We come up with crazy ideas and have the ability to think outside the box because we’re not beholden to any existing technology. We don’t have anything stopping us.”

For some members of the team, this is the first time they’ve designed a project that had to make sense in the real world.

“I learned to consider many practical problems,” recalls Han Hu, a PhD candidate and the student leader on the team. “Is the design cost-effective? How long will the structure and material sustain before fatigue? Is the design safe to run 24-7-365?”

In May, Sun and her team received word that they had been awarded a larger, $3 million grant to manufacture a second, more evolved prototype.

This new grant comes from ARPA-E, a government agency formed in 2009 to fund out-of-the-box energy technology innovations.

This time, the team’s previous grant funder is their partner on the project — a validation of sorts. The new proposal uses the same fundamental concept of moving phase-changing material from the steam side to the air side, but with a different circulation technique. Rather than pumping and spraying the phase-change material, it encapsulates it in a highly porous mesh-type structure.

The new concept addresses the potential for contamination that was inherent in the original prototype.

“You have these particles being sprayed around, and if they get dirty that can clog your system and can hurt performance over time,” McCarthy says. “This new idea has none of those concerns, but it has some other concerns. We’ve shifted the drawbacks from contamination to performance. The new idea we’re proposing is arguably more reliable, but the performance might be a little bit less and the cost might be a little bit more.”

If a practical design emerges from the academics’ blackboard, it will be a step toward protecting the country’s energy security. In 2009, a U.S. Department of Energy report imagined a scenario in which at least 25 percent of the nation’s thermoelectric capacity used dry cooling technology and the rest was converted to the wet recirculating type. If such a situation became reality, it would reduce the industry’s need for freshwater by more than 25 billion gallons a year — one of the better scenarios modeled by the DoE.

“Our goal is usually to publish a sexy, high-impact paper to our community, but this is quite different,” Sun says. “This is real-life challenges. You are using some of your fundamental knowledge and turning it into practice with the hope of changing the world with groundbreaking technology.”

THE GREAT THERMOELECTRIC THIRST
Each day, the nation’s thermoelectric power plants withdraw an estimated 161 billions of gallons of water for cooling — enough to supply 160 cities the size of New York with drinking water. Thermoelectric power plants are responsible for 41 percent of all freshwater withdrawals in the United States in a given year, more than any other sector, and supply 90 percent of America’s energy. Much of the water they withdraw is recirculated, rather than consumed; nonetheless, the overwhelming majority of plants are based on designs that require a steady, abundant source of cool water.

Thermoelectric power plants create electricity by converting steam heat to mechanical energy. They boil water to create steam, which then spins turbines to generate electricity, according to an explanation from the Union of Concerned Scientists.

The heat used to boil water can come from burning a fuel, from nuclear reactions, or directly from the sun or geothermal heat sources underground.

Once steam has passed through a turbine, it is condensed back into a liquid so it can be reused to produce more electricity. Typical power plants condense this steam by cooling it using water drawn from a nearby lake or river.

There are three main types of cooling systems used by thermoelectric power plants.

Once-through withdraws cool water from a nearby source (a lake, river, ocean, etc.) and circulates it through condensers that are exposed to the steam leaving the turbines. The now warmer water is discharged back to the source. This is an older, simple design that works well in areas that have abundant supplies of cool water. However, when discharge water exceeds temperature limits, fish life is threatened.

Since the 1970s, more power plants have been built or converted to recirculating or closed-loop cooling systems. These systems reuse the discharge water in a continuous cycle rather than return it to the source. In order to cool the water down so that it can be used again, most plants use cooling towers that spray water through the air; others use outside cooling ponds. These systems withdraw less water overall than once-through systems, however, more water is lost to the environment due to evaporation.

Dry-cooling systems require no water; instead they use lots of metal to create a large surface area to cool the steam leaving the turbine using air. Though they conserve water, they cost more to build and are less efficient than other methods. They account for only about 1 percent of U.S. power plants.
Running is one of the most convenient forms of exercise available — it’s cheap, you can do it practically anywhere, year-round, and there is no heavy equipment needed, or membership required. Small wonder attendance at races and marathons has soared in recent years.

But alongside this list of “pros,” is a serious “con” demanding attention: the high risk of injury.

Running injuries are fairly common — in an average mile-long course, a runner makes impact with the ground about 1,500 times. Multiply that by the length of a 26-mile marathon and that’s 39,000 opportunities for something to go wrong. By one estimate, if 10 friends were to start a new running group, five to seven of them would be injured within a year. The most typical running problems, called overuse injuries, range from tibial stress fractures (sometimes called shin splints), patellofemoral pain (pain behind the kneecap) and plantar fasciitis (pain in the heel).
Milner is an associate professor in the Department of Physical Therapy and Rehabilitation Sciences in the College of Nursing and Health Professions and a fellow of the American College of Sports Medicine.
Yet while running has rapidly gained new converts, the science of running and rehabilitation is racing to catch up.

At Drexel University, rehabilitation scientists are now working alongside each other in a new facility to understand how injuries happen and help injured runners get back in the race. Introduced last fall, the University’s new state-of-the-art College of Nursing and Health Professions facility combines researchers and clinical resources (called Parkway Health & Wellness) in 23,000 square feet in Center City.

One highlight of the site’s research capabilities is a windowless room equipped with high-tech sensing equipment and cameras, called the Gait Lab.

Here, research participants don running shorts and special tracking markers and practice dashing across a group of sensing plates embedded in the floor, while cameras and a nearby computer monitor tracks and analyzes their movements.

The room is the setting for a number of studies related to running, including one that examines “foot strike pattern” and its link to overuse injuries.

Foot strike pattern refers to how or where a runner’s foot strikes the ground. It has become a buzzword in running circles in recent years because of the popularity (or notoriety) of barefoot running and “minimalist” shoes — a trend pioneered by Vibram’s line of FiveFingers glove-like footwear.

Runners raced to buy Vibram’s shoes on the promise of a barefoot-like experience that protected feet from injuries and strengthened running muscles. But the company had no scientific data to back it up, and last year Vibram agreed to pay out $3.75 million to past customers to settle a class-action suit that alleged that the company made false health claims.

If nothing else, the lawsuit shines a spotlight on the dearth of research in this area.

One of the studies underway in the Gait Lab takes the barefoot/shod debate out of the equation and studies runners’ movement to better understand the mechanics of overuse injuries. For example, if you naturally land with your heel first (rearfoot strike), you might be more likely to develop bony injuries such as tibial stress fractures.

Clare Milner, the associate professor in the College of Nursing and Health Professions who heads the study, is focusing on how foot strike differences between men and women play into the types of injuries they experience.

“Men and women get injured at different rates, and often with different injuries — female runners are more likely to get Iliotibial band syndrome (pain on the side of the knee), and male runners get Achilles tendinitis more often, for example,” she says.

The goal of the study, Milner says, is to eventually develop some evidence-based rehabilitation.

Milner and colleagues call it “gait retraining.”

“We want to modify the way a person runs to get them into a pattern that is going to protect them from those injuries,” Milner says. “It’s the same idea as coaching a pitcher: It’s expected you’ll be coached on your pitching technique. We are interested in training a runner to alter their running technique if they have aberrant biomechanics, as a way to avoid or reduce the risk of those injuries.”

Some studies have shown that a rearfoot striker may experience less impact on the lower extremities by switching to a forefoot strike, or landing more on the ball of the foot.

But Milner points out that while preliminary results show less impact with a forefoot strike, there really is no universally “right” foot strike.

“Nothing is that simple,” she says. “That’s why we really wanted to dig into this.”

In the Gait Lab, Milner performs a gait analysis using the room’s system of sensing equipment and recording software. The lab is equipped with numerous cameras to record a runner’s movement. Exactly 68 reflective tracker balls are attached to the subject at key anatomical points: the foot, knee, trunk, etc. As the study participant runs through the center of the room, he or she passes through a circle rimmed by eight cameras that detect the trackers and capture his or her running biomechanics. Force plates hidden in the floor measure the ground-reaction force when the runner strikes the ground.

Together, these tools and accompanying software provide a 3-D picture of a subject’s joint torque and movement for the lower extremity joints.

The study is currently in its data crunch phase, and Milner and her team are realizing there actually is a "right" way to run, or at least a “better” way, in order to avoid in-
jury. The catch is that it’s different for every individual; the one-size-fits-all approach to treatment just won’t work. “It’s really just a matter of teaching people to run in the way that’s best for them so they can stay with their active lifestyle,” Milner says.

By consulting with physical therapists who operate in the same building, runners can make changes to their form to keep them going strong, prevent future injuries and even improve their performance. Changes can include altering one’s foot strike pattern, or making changes to one’s step width and step length.

For Kelly Shaffer, a 17-year-old high school junior who runs track, a short visit with a physical therapist at Parkway Health & Wellness was enough to keep her on her feet. When her spring track season last year was cut short because of painful shin splints, her athletic trainer referred her to Drexel’s Robert Maschi, an assistant clinical professor and expert in gait retraining who operates a runner’s clinic out of the same facility that houses the Gait Lab.

In Maschi’s clinic, runners’ movements are monitored from multiple angles by video that is then subjected to a two-dimensional motion analysis. “From the video, we can assess for movement patterns that may put the runner at increased risk for injury,” says Maschi. “This involves looking at stride length, stride width, foot strike pattern and total amount of movement at all joints during running. Using this information in combination with the client’s running history and musculoskeletal exam, we can make recommendations regarding gait modification, exercise intervention, change in shoes or orthotic inserts and training plan.”

“It was just one afternoon, for about an hour or so; Dr. Maschi had me run on the treadmill and complete some other strength tests,” Shaffer says. “The primary thing he said for me to do was not to heel strike. He recommended I change my cadence in order to do that. And now I’m a mid-foot striker.”

The small adjustment made a big impact. “The problem didn’t go away completely, but I think it did make it better,” she says. “I have less pain and it helped me put off actually having a stress fracture. And,” she proudly adds, “I was able to finish the whole cross-country season.”

NIMBLE SCIENCE

The Gait Lab inside Drexel’s new College of Nursing and Health Professions facility is equipped with cameras and wearable markers to help researchers study running movements and foot strike patterns.
Scientists from Drexel and the Academy of Natural Sciences of Drexel University regularly discover, describe and pen new species into the catalog of life on Earth. Here are some of the most recent — from the slimy to the winged to the squirmy and microscopically beautiful — that have made their way into the scientific record.

SEVEN NEW SNAILS IN THE THALA GENUS
Snails can speak to scientists from beyond the grave. Some snail species, including most in the genus Thala, are known to science primarily through the characteristics of their shells, found after the living animal inside the shell has died and decayed. In 2014, seven new species were described by Academy scientists including Gary Rosenberg, Pilsby chair of malacology and a professor in the College of Arts and Sciences. Rosenberg and his collaborators described the seven new species based on observing the shells under a dissectioning microscope before using scanning electron microscopy (SEM). The SEM showed them that the tiny microstructures of the shells can be unique to different species.

THORNY CATFISH — NEMADORAS CRISTINAE
Nemadoras cristinae entered the scientific record as a result of a collaborative effort by the world’s four top authorities in thorny catfishes, or doradids: Mark Sabaj Pérez, collection manager of ichthyology at the Academy; Mariangeles Arce Hernandez, a postdoc at the Academy; and Brazilian scientists Leandro M. Sousa and José L. O. Birindelli. Sabaj Pérez and other Academy ichthyologists have worked extensively on studies of fish of the Amazon basin, including a major NSF-funded project to document the biodiversity of fishes in the Xingu River before and after the installation of the Belo Monte dam.

STONEWORT — TOLYPELLA RAMOSISSIMA
Rick McCourt, associate curator of botany at the Academy of Natural Sciences and a professor in the College of Arts and Sciences, was part of the team that named a new species of stonewort (a type of algae) from Colorado. The team named the stonewort Tolypella ramosissima, which means “little forceful one with many branches.”
NEW DIATOM SPECIES
A diatom is an incredible storyteller packed into a tiny package not visible to the naked eye. These microscopic, single-celled plants live in waterways worldwide and can tell scientists a lot about the conditions of the environment. Marina Potapova, assistant curator of diatoms at the Academy and an assistant professor in the College of Arts and Sciences, is one of the world’s top authorities on diatoms. In 2014, 13 new species were added to the scientific record with Potapova’s help.

CRANE FLY - HETERANGAEUS MONGOLICUS
Crane flies are an extremely diverse group of insects. About 15,000 species are known, and scientists estimate there may be about 10,000 more species not yet described. Two new species are now known to science thanks to the efforts of crane fly expert Jon Gelhaus, curator of entomology at the Academy and a professor in the College of Arts and Sciences, and his collaborators. In 2014, Gelhaus described the crane fly species Heterangaeus mongolicus (pictured) and Trentepohlia inexpectata, both from north central Mongolia. The discovery was one of many as part of the NSF-funded Mongolian Aquatic Insect Survey project that Gelhaus leads.

78 NEW GRASSHOPPERS
In 2014, 78 new grasshopper species including this one (Philocleon azumai) were added to the list of known species by Dan Otte, world expert on crickets and grasshoppers and entomologist at the Academy of Natural Sciences of Drexel University. Otte is also an expert in time management — 55 of those new species were new African grasshopper species added to the world list on Dec. 31, 2014.
Some of the same chemical reactions that occur in the atmosphere from smog and ozone are taking place in your house while you clean.

Many cleaning products and air fresheners leave behind a sweet or citrus-y fragrance, but don’t be fooled by that “clean” smell. Michael War ing’s research examines the byproducts these pleasant-smelling compounds are adding to the air while we use them to remove germs and odors.

Secondary organic aerosols (SOAs) are microscopic particles created when ozone reacts with volatile organic gases such as limonene — the chemical name for the smell of orange — or its cousin pinene, which produces the smell of pine trees. Outdoors, this reaction happens all the time. It drives the formation of much of the atmospheric organic aerosol present in our environment. And in population-dense urban areas — where enough suspended particles can be amassed — it contributes to the formation of smog.

While a large amount of aerosols that exist in the Earth’s atmosphere are naturally occurring, much is produced as a result of industrialization and studies have linked exposure to outdoor aerosols generally to poor health outcomes. Few researchers, however, have considered the formation of SOAs in our indoor environments. “SOAs can come from ozone reactions with numerous sources, especially with compounds called terpenes that produce the scents we associate with cleaners, pine, lavender and oranges,” he says. “Limonene…is a very popular scent for cleaning products, so we’re taking a closer look at how it reacts indoors, where people are using it in high concentrations.”

Waring and his team used an air-testing chamber specifically designed to study the reactive behavior of air in an indoor environment. With it, they were able to simulate limonene being added to the environment in pulses — the way it would be introduced indoors when spraying a limonene-containing cleaning product. “Our findings show a significant enough range of SOA formation to warrant more in-depth public health studies,” says Waring.

Waring recommends using unscented cleaners and opening windows while cleaning as ways to reduce indoor aerosol formation. Even though open windows bring in more ozone from outside, the reduction in the indoor limonene concentration and SOA formation strength more than make up for it.

The Swann Memorial Fountain in Center City is a place for coin tossing and feet splashing — but scientists also collect specimens there to learn more about the urban insect population.

Last year, Drexel’s Isabella Betancourt spent part of each day in Philadelphia’s Logan Circle, splashing around in Swann Memorial Fountain. The former curatorial assistant at the Academy of Natural Sciences of Drexel University cataloged Philadelphia’s insect diversity by using the fountain as a giant insect trap. Her urban entomology biodiversity project tracked the variations and populations of insects to create data about how green Philadelphia’s environment really is.

Betancourt dreamed up the project soon after she started working at the Academy in 2012. “It was hard being inside all the time and working with so many dead insects in the collection,” she says. “I wanted to go in the sun and work with living insects.”

By cataloging the types of insects and their presence in the fountain, researchers can then use them as bioindicators to investigate the city’s environmental conditions. The data can reveal the natural history — the life cycles, habits and environmental requirements — of those insects and how it’s evolved in Philadelphia. If the water becomes polluted, aquatic insect diversity will drop; if the water becomes cleaner, diversity will increase.

Everything Betancourt collected joined the Academy’s specimens, including a species of cuckoo wasp not previously held in the collection.
**_URBAN WATER ALLIANCE_**

Drexel, NJIT and Rowan have partnered to examine the water resource challenges facing the Northeast.

Water is a critical right, a contested commodity and a fragile resource — and its importance will only expand as population growth and climate change continue.

To ensure that academic expertise is part of the future conversation, Drexel has partnered with the New Jersey Institute of Technology and Rowan University to draw on the strengths of water experts at all three universities.

With experts in public health, flooding, water contamination and much more, this new research alliance aims to solve the challenges that affect the region’s water resources.

“Developing relationships between industry and academia are essential steps toward understanding how we can mitigate water resource and management problems in a society that will always face increased industrialization and commercialization,” says Drexel’s Charles Haas, the L.D. Betz professor in the College of Engineering.

Some of the early goals of the alliance include organizing presentations about water resource protection, offering courses about water use and creating an online portal for communicating and sharing information between institutions.

The founders also expect their group to become a resource for public policy and technological development in other regions of the United States and the world.

**_THINK_TANK_**

The alliance aims to be a one-stop shop for connecting industry with academic experts.

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**_HALF-AND-HALF_**

Inside the Academy of Natural Sciences of Drexel University, an unusual butterfly provides a living lesson on the diversity of life.

This Lexias paradoxa butterfly emerged from its chrysalis in the Academy’s Butterflies! exhibit and spread its wings to reveal a genetic abnormality known as gynandromorphy.

Its two right wings — brown with yellow and white spots — were characteristic of a female of the species, and its two left wings — darker with green, blue and purple coloring — were typical of a male. The right wings were shaped differently than the left, and the body’s coloration was split lengthwise down the middle as half male and half female.

How does it happen? Gynandromorphism, says Entomology Collection Manager Jason Weintraub, “is most frequently noticed in bird and butterfly species where the two sexes have very different coloration. It can result from non-disjunction of sex chromosomes, an error that sometimes occurs during the division of chromosomes at a very early stage of development.”

The butterfly was discovered by chance and was exhibited for a curious public before becoming a permanent part of the Academy’s Entomology Collection of more than 3.5 million specimens.

**_MIDDLESEX_**

This butterfly emerged with features of both sexes. It has the coloration and slightly smaller shape of a male on its left half and the drabber characteristics of a female on its right half.
Six research projects earned support in the first round of funding by the newly established A.J. Drexel Institute for Energy and the Environment.

Across the University, researchers have been working to answer complex questions about energy and the environment. In 2013, those efforts were united under the new A.J. Drexel Institute for Energy and the Environment, formed to support the creation and dissemination of scientific, evidence-based knowledge that informs a sustainable energy future.

Now two years in, the institute has awarded seed grants to several promising projects across the University that align with its mission to address some of the tough questions facing policy-makers today.

**SAFE AND SOUND**
One team is investigating ways to make smart grid technology more secure, and developing terminology that will allow researchers and operators to better communicate about smart grid technology.

**TESTING GROUNDS**
Another team will continue research that uses Drexel as a test platform to study smart grid interactions. The group plans to conduct interviews and workshops to gather information on Drexel’s energy measurement and technical due diligence and written with Drexel students and a colleague from the University of California-Santa Cruz.

Because brain tissue is energetically expensive, this could provide a big savings to the slave-maker workers. But don’t underestimate the slave-maker ants, O’Donnell advises. “We don’t automatically expect parasites to be ‘stupid’ — in order to be a successful parasite, you need to be very, very smart in certain specialized ways,” he says. “Slave-makers are as smart as they need to be, because their hosts are doing most of the work for them.”

The parasitic relationship between slave-making ants and their hijacked workers is a unique and effective system for studying brain evolution in social insects.

**THE COSTLY LIFE OF SOCIAL INSECTS**

Sean O’Donnell has been conducting research on brain evolution and brain investment in social insects for several years. It’s a branch of research that can inspire a better understanding of the factors that shaped human brain evolution.

For this research, he worked with Formica fusca ant workers, or common black ants, that had been forced into a life of hard labor by the slave-making Polyrhachis mexicanus ant workers. P. mexicanus ants perform little labor for their colonies; instead they serve as the colony’s thugs, invading host colonies and enslaving F. fusca workers to carry out tasks such as foraging, excavating nests and tending the brood.

O’Donnell wanted to find out if P. mexicanus’ dependence on its slaves caused a decrease in brain investment over time. Existing literature didn’t address brain reduction, or its occurrence in social parasites.

“We thought using social insects would be a cool way to test these ideas since parasitism, including social parasitism, is one context where brain tissues could actually evolve to be smaller rather than larger,” O’Donnell explains.

That’s exactly what he found after he and his team collected and analyzed neuroanatomical data from several dozen P. mexicanus and F. fusca workers. In both species, they focused particularly on the mushroom body calyx, which is like the cerebrum in humans and other mammals.

“F. fusca workers invested about 15 percent more in the mushroom body calyx (relative to the rest of the brain) than P. mexicanus slave-makers,” O’Donnell states in a paper recently published in the Biological Journal of the Linnean Society. Because brain tissue is energetically expensive, this could provide a big savings to the slave-maker workers. But don’t underestimate the slave-maker ants, O’Donnell advises.

Ants’ mandibles are their tool kits, and the differences in this image illustrate the dramatic behavioral specialization of the slavemaker workers. Like most ants, the F. fusca (slave) worker has shovel-shaped mandibles, good for carrying food, digging and other jobs. The P. mexicanus (slavemaker) worker has sharp, ice tong-like mandibles, specialized for use as weapons when raiding F. fusca nests. Researchers has revealed corresponding differences in their brains.

**HEALTHY HABITS**
A team of public health and engineering researchers will collaborate to assess health risks that could result from operational failures and regulatory violations in the natural gas extraction process.

**CLEAR WATERS**
Faculty from the College of Engineering and the Center for Hospitality and Sport Management are working to decontaminate flowback water from the hydraulic fracturing process that is used to extract natural gas from shale formations.

**BACK TO THE WELL**
Another project aims to help people whose drinking water wells have been contaminated because of fracking. Engineering researchers are developing a way to use ultrasound to remove dissolved methane from water by a process of “acoustic boiling.”

**SEAN O’DONNELL**
O’Donnell is a professor and associate department head for the Department of Biodiversity, Earth and Environmental Science in the College of Arts and Sciences.

**Hugh P. Johnson**
Johnson is a senior fellow with the Institute for Energy and the Environment at Drexel. He has consulted on renewable energy, energy efficiency, energy measurement and verification and green building projects for private, municipal and federal clients, as well as provided financial and technical due diligence for companies.

**F. fusca**

**P. mexicanus**
MYSTERY FISH DEFIES CLASSIFICATION

_Kryptoglanis shajii_ is a strange fish—and the closer scientists look, the stranger it gets.

*Kryptoglanis shajii* is a small, pinkie-sized subterranean catfish that sees the light of day only rarely, when it turns up in springs, wells and flooded rice paddies in the Western Ghats mountain region of Kerala, India.

It was first described as a new species of catfish in 2011. Soon after, John Lundberg, one of the world’s leading authorities on catfishes, started taking a closer look at several specimens.

“The more we looked at the skeleton, the stranger it got,” says Lundberg, emeritus curator of ichthyology at the Academy of Natural Sciences of Drexel University and emeritus professor in the College of Arts and Sciences. “The characteristics of this animal are just so different that we have a hard time fitting it into the family tree of catfishes,” he adds.

His team’s study describing the detailed bone structure of _Kryptoglanis_ was published in the 2014 issue of the _Proceedings of the Academy of Natural Sciences of Philadelphia_.

From the outside, _Kryptoglanis_ doesn’t look particularly unusual for a catfish. But when Lundberg and his colleagues looked at its bones using digital radiography and high-definition CT scans, they found some surprises.

_Kryptoglanis_ was missing several bony elements—a characteristic fairly common for subterranean fish. There were also changes in the shapes of certain bones. Numerous individual bones were modified in the face, giving the fish a compressed front end with a jutting lower jaw.

Why _Kryptoglanis_ is so different, and what its closest relatives are, remains a mystery. This fish is just one of many unresolved branches on the catfish family tree, in a section where even DNA evidence has thus far proven unhelpful. Subterranean species like _Kryptoglanis_ tend to have dramatically different DNA sequences from one another and from their open-water relatives, making it difficult to identify their evolutionary histories.

“It continues to be a puzzle,” Lundberg says.

This elusive little subterranean fish has a bone structure all its own.
Discovered a decade ago and preserved in secrecy until just last year, the record-setting new dinosaur species Dreadnoughtus schrani is informing the way scientists think about the largest animals to ever walk the surface of the Earth.

By Rachel Ewing / Photos by Robert Clark
Finding a dinosaur in Patagonia is not difficult, if you know what to look for.

It was therefore not a surprise to Drexel professor and paleontologist Ken Lacovara when a member of his field expedition team discovered a dinosaur femur in Argentina in early 2005.

The size of the giant creature it belonged to and the remarkable completeness of its skeleton, however, came as pleasant shock.

In the Connecticut-sized area where Lacovara has the rights to prospect for Cretaceous fossils, virtually every rock on the ground is a fossil, and many of those fossils are dinosaurs.

“The first field season we could see there was a huge amount of potential in the area,” Lacovara recalls of his team’s first expedition to Patagonia in 2004. “Anybody would conclude it would be a matter of time before we found something pretty good. It turned out it was a short amount of time, and what we found was way beyond pretty good, better than I could have reasonably hoped for.”

But it took a great deal more time — nearly a decade — from that moment of discovery until the world at large heard the full story and the dinosaur’s thunderous name: *Dreadnoughtus schrani*.

Lacovara estimates he spent about a year of his life over four field seasons sleeping in his tent in Patagonia while digging up *Dreadnoughtus*. At one point during the years of fossil prep in his lab, he tried to track the hours spent at work there. He gave up and just counts the total by order of magnitude: Thousands of man-hours went into preparing those bones over a period of five years, removing the thin outer layers of rock, stabilizing decompression cracks and reassembling bits that had crumbled with glue and putty. Thousands of hours were spent over two years scanning the bones with lasers to preserve digital models of the individual bones. Writing the manuscript of the scientific paper took about a year and a half.

“There are paleontologists who would step over *Dreadnoughtus* and keep on going,” Lacovara says. “Maybe they’re smarter. They would dig up and publish five dinosaurs in the time I spent on just this one. But I want to do the things that are hard. I feel a responsibility toward the animal. Once you find it, you’ve got to take care of it.”

It wasn’t until Sept. 4, 2014 — during a press announcement at precisely 9 a.m. — that the name “*Dreadnoughtus*” was first spoken aloud and in public.

That was the moment that Lacovara’s team published online a scientific paper naming and formally describing the extraordinary new species in the journal *Scientific Reports*.

At 65 tons in life with a body the size of a house, this new dinosaur is the largest ever discovered for which a mass can be accurately calculated — and this individual was still growing when it died. With a skeleton far more complete and well preserved than any other of the largest-known dinosaurs, this specimen is poised to reveal new information about the physical workings of life at the upper limits of size for animals on land.

**EVERYTHING IS MULTIPLIED**

“Work goes into every discovery when you have a dinosaur that’s brand new; but in this particular instance, everything was so big, everything is multiplied,” recalls one of the students on Lacovara’s team, Elena Schroeter (PhD ’13), who began working on *Dreadnoughtus* during the team’s final field season in 2009.
Ken Lacovara’s son, Rudyard, now 7 years old, is probably the person least impressed by *Dreadnoughtus*. He was not quite 2 years old when a shipping container filled with *Dreadnoughtus* fossils arrived in Philadelphia, so as far as he’s concerned, dad has always had a dinosaur.
The size of the beast wasn’t immediately apparent to the team when they struck unreasonably good luck on the first day of the field season. All they could see at first was one tiny piece of bone peeking through the sediment.

But by the second day, the whole field team was digging, and the more they dug, the more they saw.

“When we have to work in order to take one bone out, another bone appeared under it, so we had to go deeper and deeper,” says Lucio Ibiricu (PhD ’10), who was part of every field expedition with Lacovara in Patagonia — initially as an Argentinian undergraduate volunteer, then as a doctoral student at Drexel. “When we work on one bone, another bone appeared under it, deeper. This was a nice problem to have.”

Nights were cold, and days were baking hot. Temperatures also swung without warning.

At times in the quarry, the wind would come rolling over the hills and the team would stop and look at each other, knowing.

“It was just enough time for us to take cover, duck down and cover our faces with our shirts,” says Alison Moyer (BS ’08), who excavated Dreadnoughtus during two field seasons as an undergraduate. “It was raining dirt and rocks and the wind would just take over.”

It took two more field seasons to extract all of the dinosaur’s remains.

CHIPPING AWAY

For the first several field seasons, while plaster jackets filled with Dreadnoughtus bones piled up, Lacovara remained unsure whether his discovery would ever leave Argentina for detailed study.

Fossils found in Argentinian soil belong to that country, and negotiating a research loan in a multilingual mix of science and legalese took countless suspenseful hours of negotiation and muddy translation. By 2009, the loan was finally secured.

The dinosaur finally arrived in Philadelphia by shipping container in May 2009 with a cargo of 234 jackets protecting 16 tons of bones. A boisterous crowd celebrated the opening of the container at the port.

Then a group of 20 experienced fossil preparators got to work unloading the heavy jackets from the truck.

The dinosaur’s journey was only halfway done. Years of prep work remained ahead, in Lacovara’s lab at Drexel as well as at the Academy of Natural Sciences of Drexel University and at the Carnegie Museum of Natural History in Pittsburgh.

Preparation is the process of removing protective layers from the bones, including the plaster jackets added in the field and the thin layer of surrounding rock that was left on each bone in the field to stave off potential damage from decomposition. Part of prep is also restoring the bones, filling in cracks and fitting together broken pieces, as well as stabilizing and filling in decompression cracks that form when the surrounding rock is removed.

“The thing people don’t realize about [fossil] prep work is it’s so dirty,” Schroeter says. “Doing prep for any length of time, you get glue on your pants and dust absolutely everywhere.”

At 65 tons in life with a body the size of a house, this new dinosaur is the largest ever discovered for which a mass can be accurately calculated — and this individual was still growing when it died.

The very last bone, the cervical vertebra, was one of the trickiest to prepare. This fragile and extremely rare 3-foot-wide bone that Moyer had spent a field season excavating, was not only large, but craggy, filled with hollow, bowl-shaped fossa. Only the most experienced fossil preparators in the lab, Schroeter and Aja Carter (BS ’14), were trusted to handle the special fossil.

“This bone is a neck bone, but it’s the size of me if I curled up, or bigger,” Schroeter says.

Using mini-jackhammers called airscribes is usually a reasonably easy way to clear excess sediment off of the surface of a bone — but not so with this cervical.

“When you blow air away from you into a bowl, guess where it goes? Back in your face,” Schroeter says.

Throughout that winter, the pair showed up to work in bandanas, goggles and face masks. Eventually, they added two pairs of machinists’ coveralls borrowed from Schroeter’s dad. Once they flipped the vertebra to the other side, which had been recovered in plaster, the mess only got worse, and Carter discovered a plaster allergy — but that’s another story.

Carter put in far more of her prep time over the years at the Academy. As a longtime volunteer, Carter spent many of her undergraduate years in the Academy’s public-facing lab while preparing this dinosaur under the supervision of Dreadnoughtus field team member Jason Poole.

“I got to see kids’ faces, gaping, wide eyed,” she recalls. “We had this femur propped against the wall. They didn’t always know what a femur was, but when I asked them to look at their thigh bone, and then said, ‘This one bone is as tall as your mom or your dad or your aunt’ — it took them a second, but then they got it.”

Lacovara’s team produced 3-D digital scans of all of the Dreadnoughtus bones so that they and other scientists could continue to study the dinosaur without the need to travel or move the oversized and irreplaceable fossils.
Dreadnoughtus wasn’t always a pile of bones, of course — what makes it so interesting, so worth the decade of hard labor for dozens of people, is all that those bones reveal about the living animal it once was and about the ancient history of life on Earth, previously unknown.

“When you touch a dinosaur bone, you know you’re touching something that was alive, that moved, that had to eat, that walked,” Carter says. “It’s a connection between you and it and geologic time.”

Dreadnoughtus, for an animal so astonishingly huge, somehow managed to do all the ordinary and mundane tasks common to life, from eating and walking to breathing and reproducing. Yet doing so for an animal so large is hard to contemplate. Can you picture a two-story house eating, breathing and sometimes standing up to take a walk? You would want to get out of the way.

The imposing size of this animal is just part of the reason for its name, meaning “fears nothing” and inspired by early-20th-century battleships called dreadnoughts. (The dinosaur’s species name, “schrani,” was chosen in honor of American entrepreneur Adam Schran, who provided support for the research.) In life, this dinosaur also would have feared no threat in its environment because of its powerful muscles.

In many of the exquisitely preserved fossil bones, deep grooves show the points of attachment for those muscles. Along the 30-foot tail, each vertebra pairs with a set of bones called chevrons that have a spur of bone pointing downward where the tail-wagging muscles attached. In other long-necked, long-tailed sauropod dinosaurs, those attachment spurs taper down to a fine point, but in Dreadnoughtus they flare out into wide paddles for a strong muscle attachment point. This gave the creature what Lacovara calls a “weaponized tail.” It could swat any predator away easily without slowing down its steady vacuum-slurp of all the vegetation it could reach.

Of all the ecological questions about how Dreadnoughtus lived in its environment, one thing is certain: Dreadnoughtus was an herbivore. Only plant-eaters can possibly grow to be the largest animals in an ecosystem because a large percentage of their energy is lost with each step up in the food chain — and for an animal as large as Dreadnoughtus, it would take a large percentage of all the energy an ecosystem could produce just to maintain its body size.

Lacovara speculates that to maintain its body size, Dreadnoughtus would need to eat all of the vegetation within reach of its 37-foot neck, then take a few steps to one side and start the process all over.

Many more questions about how Dreadnoughtus lived and moved may be answerable and testable thanks to the many types of bones that were recovered and the quality of their preservation. Lacovara and his current and former students are already at work on several additional scientific papers addressing biomechanical questions as well as more technical analyses of the shape of the bones.

A TINY ROBOT REPLICA?
One area of ongoing research will employ new 3-D modeling techniques to study how giant dinosaurs managed to live and move. As part of the preservation process, Lacovara’s team produced a comprehensive set of 3-D digital scans of all of the
Dreadnoughtus bones so that they and other scientists could continue to study the dinosaur without the need to travel or move the oversized and irreplaceable fossils. Lacovara published the 3-D scans as freely available PDF files on the website FigShare, where they became the most-downloaded scientific figure in the site’s history up that point.

Lacovara and his students are collaborating with two engineering labs at Drexel to produce both digital and robotic 3-D models of Dreadnoughtus to test their hypotheses about the dinosaur’s biomechanics. Working with Professor Soren Siegler and Associate Professor James Tangorra, both engineers in Drexel’s College of Engineering Department of Mechanical Engineering and Mechanics, they are adding virtual muscles and other soft tissues in a virtual space and 3-D printing 1/10th scale models of the bones.

With the addition of attached model muscles and tendons, the researchers will have a small robotic model of Dreadnoughtus. An advantage of building a dinosaur robot is that there is no need to simulate the physical environment — characteristics such as gravity and air pressure — because the model can interact with the real world during an experiment.

“The one thing we can assume about these supermassive giants is that they’re extremely efficient with every calorie that they take in,” Lacovara says. “You can’t get that big otherwise. So as we develop these robotic models, we can measure the energy going in, we can measure the energy consumed, and then we can tweak the model to try to find a more efficient form. And the closer we get to the most efficient form, I think, the closer we get to the truth of how these animals existed.”

THE PAST IS PROLOGUE

The impact of Dreadnoughtus research extends far beyond Lacovara’s own lab at Drexel. “Dreadnoughtus has become an important data set in the study of sauropods,” Lacovara says. “If you’re writing about the environment, evolution and anatomy of sauropods, there’s a pretty good chance you want to include this one.”

As for the students who worked alongside him, their experience with the fossil has helped them move ahead in the field and in graduate programs.

“Dreadnoughtus has really been a big career boost for the students,” Lacovara says. “Other professors know they worked on this, that they have good skills and can do the hard work.”

Moyer is now in the final year of a PhD program at North Carolina State University in molecular paleontology, a new subspecialty pioneered by her advisor, Mary Schweitzer, who famously extracted soft tissues and proteins from T. rex fossils. Schroeter is joining her there as a postdoctoral fellow. Ibiricu is a scientist with Argentina’s equivalent of the National Science Foundation. Carter is beginning a doctoral program in paleontology at the University of Pennsylvania.

Dreadnoughtus itself, meanwhile, has returned home to Argentina — shipped back in a hefty load of crates that departed Drexel in December 2014.

Jason Poole once told Carter that, as paleontologists, they have the glorious job of ushering ancient animals into their afterlife.

For Dreadnoughtus, the afterlife has finally begun.
Perhaps only Jason Weckstein, an expert in bird lice, would refer to the raining down of parasites from a fumigated bird specimen as “a mine full of riches.”

The sight of their tiny corpses trickling from hiding places amongst the barbs of the bird’s feathers can set Weckstein’s mind reeling. He knows they have a story to tell and he is one of a small minority of scientists tuned to listen.

Weckstein is a self-described “dual personality,” a kind of hybrid scientist who studies both birds and the parasites that love them, with a particular focus on avian chewing lice. As an evolutionary biologist, Weckstein considers it his duty to fill in gaps in the tree of life, and parasites can reveal much about their hosts, he says.

“Birds are whole little worlds in themselves and filled with different creatures living on them and in them,” Weckstein enthuses. “It’s a great system for asking a lot of questions.”

Thirty to 70 percent of life on Earth is parasitic, Weckstein explains, and there is good reason the range is so broadly estimated.

“There is so much unknown life on our planet — there are unknown birds on our planet, and there is certainly unknown diversity within species of birds on our planet that we don’t understand,” he says. “If we want to conserve it, if we want to know anything about it, we’ve got to study it.”
The combination of 19th-century collecting and fieldwork and modern-day technology is another reason why Weckstein’s work is so unique.

“One of the things that I love about my job is that I get to have my foot in two places,” Weckstein says. “One is this sort of old-fashioned 19th-century exploratory work in places where we don’t even know what lives there. Then we can come back to the lab and use modern techniques like DNA sequencing, which can inform us about biodiversity and evolution in ways that 19th-century scientists couldn’t even imagine.”

Weckstein says sequencing DNA is another way to add crucial information to the tree of life, and a new generation of DNA-sequencing technology has made it easier and less expensive.

“It used to be that we were sequencing maybe 300 to 1,000 letters of the [DNA] code,” he says. “Now we can sequence millions of letters of the code and it tells a lot more — and we can do it for much cheaper.”

Sequencing the DNA of a louse species, for example, costs about $1,000, Weckstein says. He submitted a preliminary proposal to the NSF earlier this year to continue this work.

“We’re trying to get a good, solid sense of what the evolutionary history is of a particular group, so we’re building the tree of life,” he explains. “In order to know statistically that we have the right tree of life, we need a lot of data. And getting this huge amount of data for a lower price is allowing us to have a much better, more well-supported evolutionary tree.”

Specimens collected from the field and added to the collections have much more than DNA to offer — there are endless possibilities for study.

“With bird specimens, you can take tissue samples or blood samples for malarial or Lyme disease work, you can use parasites to look at disease ecology or parasite ecology. And that’s not even scratching the surface,” he says. “Ten years from now, someone might want to come in to look at plumage coloration patterns or molt or phylogenetics or any number of things and can use the same specimen.”

Weckstein brings his unusual research focus, experiences from his fieldwork and access to the Academy’s Ornithology Collection — which is the second-largest university-based collection in the world — to a new course for Drexel students that started this year.

“The combo of things that he does gives his research that extra level of interest,” says Ted Daeschler, an associate professor in the Biodiversity, Earth and Environmental Science Department and vice president for collections at the Academy. “He’s innovative, and his research program shows students the power of being open to new methods. It shows students that research is a creative process and they can think a little bit outside the box.”

— Jason Weckstein, Academy of Natural Sciences of Drexel University

“...and how diseases travel between birds, parasites and humans.”

Currently, Weckstein is the lead principal investigator on a project funded by the National Science Foundation to conduct collaborative biodiversity surveys to collect, preserve and study avian parasites. The main focus of the project is parasites that are associated with birds that inhabit several geographically isolated areas of southern Amazonian Brazil.

Weckstein works closely with colleague Alexandre Aleixo, curator of birds at the Museu Paraense Emílio Goeldi in Belém, Brazil, to collect bird specimens that will be added to the collections of both the Academy and the Museu Goeldi.

The project team, which also includes colleagues at the University of North Dakota and The Field Museum in Chicago, will analyze genetic data for these birds and their parasites to reconstruct their evolutionary histories.

Weckstein is interested in more than just filling in the tree of life. He’s also curious about parasites’ dispersal behavior. Many types of parasites are host-specific and remain on one bird species for an entire life cycle (usually about a month). But Weckstein’s fieldwork and laboratory work, in collaboration with colleague Michel Valim at the Museu de Zoologia da Universidade de São Paulo, has turned up interesting instances of dispersal of parasites from one host group to another, a key precursor to host-switching — a louse species that is typically found on trogons (gaudy perching birds endemic to the tropics) was discovered on a toucan, for example.

How did that happen? One method lice use to disperse between hosts, Weckstein says, is by phoresis, which is kind of like hitchhiking or piggybacking. This is done with the help of a hippoboscid fly, another insect that parasitizes birds. Basically, Weckstein explains, “lice attach to the body of the fly and ride the fly like a bus to a new host.”

“We found a fly with a trogon louse attached to it and this fly was on a toucan,” he says. “It’s a great example of one of the ways in which parasites can make their way onto new hosts, what we call ‘straggling.’ Over long periods of evolutionary time, these ‘accidental’ straggling events can lead to host switching, which is an important way that parasites and pathogens move between host groups.”

And there’s a bigger application here — studying patterns of parasite transmission and evolution can help scientists trace similar patterns in the evolution of pathogens such as malaria and Ebola, Weckstein points out.

“The more we know about parasites and their relationships with their hosts,” he says, “the better prepared we are to understand how parasite diversity is generated and maintained and how diseases travel between birds, parasites and humans.”
**AIR MAIL**

A pilot project currently underway is looking at Lyme disease in birds. The project involved field work in Pennsylvania including collaborating with the bird banding station at Rushton Woods Preserve in Malvern, Pennsylvania. The work being done may help demonstrate the potential that migrant birds have as vectors for the bacterium that causes Lyme disease. This may help improve understanding of how and why the geographic distribution of Lyme disease seems to be expanding.

**INTO THE AMAZON**

This year, Weckstein mapped out two expeditions to Amazonian Brazil. One was planned for this summer to the Caxiuanã National Forest to conduct a faunistic survey of birds and their associated parasites, part of an NSF-funded project with colleagues at the Museu Goeldi in Belém, Brazil; University of North Dakota; and the Field Museum. A second expedition is planned for the fall and will go up the Rio Purus, a south bank tributary of the Rio Amazonas and a relatively unexplored part of western Brazilian Amazonia.

**A RARE BIRD**

Another project of Weckstein’s in progress involves sequencing some small fragments of DNA from the toepads of the type specimen of a bird called the Rio de Janeiro antwren (*Myrmotherula fluminensis*). This bird is only known from a single specimen, which is housed at the Museu Goeldi in Belém, Brazil. Researchers have long speculated that this specimen was just an aberrant individual of an already described species, or perhaps a hybrid, but Weckstein and his collaborators have collected data that confirm that it is in fact a unique species. Given that it has only been seen this one time, and that it was collected in what is now a very endangered habitat, their work can help bring to light the importance of searching for this bird with the hope of conserving whatever populations may remain.
The Academy of Natural Sciences of Drexel University recently completed a digital index of every specimen in its Entomology Collection in concert with a two-year, $1.2 million renovation of its insect storage facility.

Now, scientists anywhere in the world can search the collection index and obtain information about specimens available for study through an online database. The collection is worldwide in scope, and it contains many beautiful insects with spectacular morphology and color patterns, some of which are featured here.

The collection totals more than 3.5 million insects — including 106,000 identified species preserved in over 17,000 storage cases — and is one of the larger and more taxonomically complete entomological collections in North America. It’s as old as the Academy itself, and includes some of the earliest North American specimens. Parts of the collection, such as the Orthoptera and related insect groups (grasshoppers, crickets, katydids, mantids, cockroaches, etc.) rank among the best in the world, and it includes many species that are important to medicine or agriculture.

Up until recently, these irreplaceable specimens were housed in suboptimal conditions. The renovation allowed the Academy to install new hermetically sealed steel cabinets with tight-fitting gaskets around the doors and an HVAC system to control temperature fluctuations and humidity, as well as a new “clean-tile” ceiling to reduce hiding places for pests.

The new, compact shelving expands the collection’s storage space by nearly 20 percent, ensuring that the Academy can continue to accommodate new accessions and protect and preserve the collection for future generations of scientists.
BODY OF RESEARCH

ENTOMOLOGY

Toseña Paviei
Tagesoidea nigrofasciata
Trachelophorus giraffa
Papilio andraemon
Mictus sp.
The Academy of Natural Sciences of Drexel University is leading a massive, $35 million conservation initiative to ensure that the Delaware River remains a vibrant natural habitat and safe source of drinking water for millions. _by Robin Abell_
When fish biologist Richard Horwitz talks about streams in the Delaware River Basin, people listen.

Horwitz, a senior scientist at the Academy of Natural Sciences of Drexel University who has worked in the region for nearly 40 years, isn’t your typical fish expert — he’s also a student of environmental history and a keen observer of all living things. When he walks a stream, he is not only studying what’s in the water, he is also looking all around, ahead and behind.

With this perspective, he understands how the land and the streams it drains into, together forming a watershed, are connected. He and his colleagues in the Academy’s Patrick Center for Environmental Research know that everything we do on land has implications for the health of streams, the species that live in them and the people who depend on them. Since 1947, the Patrick Center has been devoted to studying the health of watersheds through its embodiment of this holistic view. The center is named for its founder, Ruth Patrick, who developed the fundamental “Patrick Principle” on which much of environmental science and management is based: that biological diversity holds the key to understanding the environmental problems affecting an ecosystem. Patrick helped to write the Clean Water Act, and over the past half century Academy scientists have continued to influence river science, policy and management.

So when the William Penn Foundation looked for an institution to help guide a massive new collaboration of conservation groups to improve water quality in the Delaware Watershed, the Academy was an obvious choice.

The foundation had honed its vision for clean water in the Delaware through early conversations with experts like Horwitz; Roland Wall, the Academy’s senior director for environmental initiatives; and Carol Collier, the former executive director of the Delaware River Basin Commission who later joined the Academy.

The William Penn team concluded from these discussions that only a sizeable investment could make a measurable difference for the Delaware’s water quality. On April 1, 2014, the foundation pledged $35 million to protect the watershed’s healthiest streams and restore impaired ones to good condition.

The foundation awarded the Academy oversight of the multi-year effort, christened the Delaware River Watershed Initiative (DRWI).

The Academy and one of its partners, the Open Space Institute, kicked off the project by identifying the highest-priority “clusters” of smaller watersheds throughout Pennsylvania, New York, New Jersey and Delaware that feed into the Delaware River Basin. Academy researchers are now guiding more than 40 grantee conservation groups as they establish baseline conditions for water quality and begin restoring areas where the foundation’s investment in conservation has the potential to do the most good.

A FRAGILE RESOURCE

From its fountainhead in the Catskill Mountains in New York, the Delaware River courses over 300 miles of urban and rural landscape and four different states on its path to the Atlantic Ocean, crossing all kinds of terrain and feeding into nearly 1,000 community water systems.

There’s a direct line from the Delaware Watershed to the health and well-being of more than 15 million people who rely on it for drinking water.

Almost half of those people live outside the basin in the greater New York City area, underscoring the importance of the Delaware for the larger region.

The health of streams in the watershed varies from place to place and is tied to surrounding land use, with water quality being more impaired in downstream agricultural, suburban and urban areas. Excess nutrients and sediment loads from increased development, agriculture and urban runoff impair some streams. Toxic pollutants — including some “legacy” contaminants like DDT and PCBs from historic activities — affect others. In some places, streams suffer from drainage from long-abandoned mines.

Nonetheless, most people in the region have access to all the clean water they need. So why invest in protecting and restoring the watershed?

“It’s true that clean, abundant water is available in the Delaware River watershed now, but we shouldn’t plan on that always being the case,” Stefanie Kroll, the Academy’s project science director for the DRWI, explains. “Recent news headlines highlight the fragility of our water supply, with hundreds of thousands losing access to clean water as a result of pollution and poor management. Paying attention to the Delaware today is essential for having the same resource quality in the future.”

BIG, BOLD AND NECESSARY

It’s nearly impossible to describe the Delaware River Watershed Initiative without illustrating the scale of effort.

The eight clusters where the project will focus together cover around 6,575 square miles, or an area larger than the size of Connecticut and Rhode Island combined.

To compare data across sites and obtain reliable results, scientists and partners must execute activities and collect data similarly from site to site. Coordination and standardization, which are baked into the initiative’s design, are rare in a project involving so many actors.

And the cast is literally in the hundreds. The coordinating group members — the William Penn Foundation, the Academy, the Open Space Institute, the National Fish and Wildlife Foundation and the Institute for Conservation Leadership — each have their own expert teams.

There are also dozens of local organizations working within individual clusters to put protection and restoration strategies into practice.

“You won’t find other watershed projects that engage so many organizations,” observes Collier, now the Academy’s senior advisor for watershed management and policy. “The DRWI is a wonderful example of how to build support from the ground up. After all, it takes all the citizens of a watershed to make a clean, healthy river system.”
A painted turtle at French Creek near Phoenixville, Pennsylvania.

Academy staff set up one of two seine nets that will block off a section of Tenmile River in Sullivan County, New York. Blocking a reach of stream prevents fish from swimming in or out of the sample area during multiple-pass collection, and ensures an accurate description of the composition of the fish community in that reach.

Academy scientists measure flow rate and discharge of Hayes Creek at Hickory Run State Park in Carbon County, Pennsylvania, using the SonTek RiverSurveyor.

In Pickering Creek near Phoenixville, Pennsylvania, an Academy scientist uses GPS to mark the exact location of a temperature logger that records water temperature continuously every 15 minutes for several months, which helps the team assess the stream’s condition over time.

These caddisfly nets were spotted in the Upper Musconetcong River in Warren County, New Jersey. Caddisfly larvae excrete silk from their salivary glands to build nets like these for protection and to collect food.
MONITORING FOR IMPACT

Good water quality is essential not only to people, but also to the species that rely on the Delaware’s aquatic systems.

From the tiniest algae to the majestic bald eagle, degraded water affects the flora and fauna living in and around it. “If you put a garbage dump next to your house, everyone who lives in the neighborhood is going to move,” says Kroll. “Animals and plants are the same way. They don’t want to live in horrible conditions, so their presence or absence tells us if something has happened in the past year.”

The disappearance from degraded sites of species that need high-quality habitat, and the proliferation of more tolerant species, is at the core of biological monitoring, she says.

At dozens of sites, Academy scientists sample algae, macroinvertebrates, crayfish, fish, salamanders and water chemistry (the Academy’s current monitoring projects on the Delaware River are described on the following pages). Together these indicators, along with measures of water flow, temperature and streamside conditions, illustrate ecosystem health.

For instance, salamanders often disappear or show abnormalities when exposed to pollutants, but the types of pollutants may be unknown. Different kinds of algae can help fill in the picture by indicating whether heavy metals or excess nutrients have been in the water.

ACADEMY AT THE HELM

Local organizations are adopting Academy protocols and undertaking their own monitoring programs at individual sites, often for the first time. Academy scientists are providing guidance, to ensure consistency of methods so that all the data can ultimately be used together.

The data from more than 300 sampling sites will help scientists understand whether the initiative’s stream restoration and protection activities are improving water quality. If they are, then there is a good argument to replicate them elsewhere in the Delaware and beyond. If they aren’t, then it’s important to figure out why and consider changing course.

Evaluating what works may seem like common sense. Yet a landmark 2005 study of thousands of stream restoration projects in the United States found that the vast majority lacked rigorous scientific evaluation of whether the projects were successful.

The DRWI built in evaluation from the start. “The William Penn Foundation emphasized the importance of scientific credibility from our earliest discussions with them,” says Wall, the Academy’s team leader on the DRWI. “They made sure that monitoring and assessing ecological quality were going to play a central role in the project.”

As the monitoring program gets fully underway this year, it will begin generating scores of datasets for integration into a single database accessible to all project partners.

This standardized dataset, which Kroll happily refers to as a “luxury,” will be an accomplishment in and of itself. But the real achievement will be using it to understand what it takes to move the needle on water quality at a scale that will make a difference to the millions of people who live, work and play in the Delaware River Watershed.

This story first appeared in Frontiers, the magazine of the Academy of Natural Sciences of Drexel University.
One simple way to assess impacts to an ecosystem and express it to practitioners and the public is to compile biological indicators, like fish and algae, into a summary index called the Index of Biotic Integrity (IBI).

However, no such index exists for the Delaware River watershed as a whole, because the basin runs through four states with their own individual approaches.

Academy scientists are working to change that. Stefanie Kroll, project science director for the Delaware River Watershed Initiative, and a team of Academy scientists in collaboration with the Stroud Water Research Center in Avondale, Pennsylvania, are visiting streams and sites to investigate how certain bioindicators relate to degradation and conservation efforts.

“This work is generating information on the Delaware River Basin and using local waterways to answer questions about watersheds on both regional and local scales, like ‘Which areas should be prioritized for conservation?’ or ‘Where can we target conservation actions so they have a cumulative effect on improving or maintaining water quality?’” she says.

To further their knowledge of the effect of conservation efforts, Kroll and other scientists are also looking into how water quality is affected by stream connectivity and tributaries that flow into larger streams. They will target certain places along the river where tributaries connect to larger streams or to pollution “hotspots.”

Altogether, the work will measure the effects of restoration and protection on water quality, and help target where these practices can have the greatest positive impact, according to Kroll. The next step is to understand how researchers can best use these approaches to determine the biggest stressors to regional streams. — Alissa Falcone

The old proverb says that “still waters run deep,” but Academy scientist Meghan O’Donnell is going one step further and asking “run deep with what?”

To find answers, she’s looking at the parts of the Schuylkill and Brandywine-Christina watersheds that are lentic, or slow-moving and without any current. There, she’ll search for macroinvertebrates (think: insects, small crustaceans, crayfish and mollusks) that can act as bioindicators to reflect the environmental conditions of the area. Typically, samples are taken from lotic, or areas where the current is strong in the center of the water column, because that’s where the area is teeming with diversity.

“There aren’t metrics for indicators of biological integrity for lentic areas,” she says. “In lentic areas, there is lower dissolved oxygen and increased sedimentation; you will find different kinds of macroinvertebrates that tend to have a high population of predators and air breathers.”

Since the organisms she’s looking at are as slow-moving as their watery habitat, O’Donnell says that the tolerance level of the macroinvertebrates sampled tells a lot about the long-term conditions of the aquatic environment. The various bioindicators give insight into the water conditions, but that’s not enough for O’Donnell. She’s still taking water samples and measuring pH, water temperature, conductivity, stream depth and width, and soil and vegetation cover at the sample sites to learn even more about the macroinvertebrates’ habitat and impact from land use.

In the future, O’Donnell hopes to compare her specimens’ tolerance level to pollutants to those sampled in the lotic areas, and potentially establish a lentic Index of Biotic Integrity, or IBI, to gauge the health based on what families of organisms are found. — Alissa Falcone
The biggest threat to water quality isn’t what’s inside the stream, it’s what’s next to it. Sediment created by erosion or runoff from farm fields can cause a horrible “domino effect” on the ecosystem, according to David Keller, project coordinator within the Fisheries Department at the Academy.

Not only does the sediment affect the light penetration and water quality, but it can also change the substrate composition already in the river. Runoff sediment can fill in pore spaces, or spaces in between the substrate, which can transform the stream bottom from something more coarse to something more fine.

“Some animals use that substrate and pore space for habitat. So when you introduce sediment into a stream, it fills in the pore space and alters the habitat for the animals that live in the stream, like fish, salamanders and macroinvertebrates,” says Keller.

Though sediment runoff is a common problem throughout the area, special circumstances have caused Keller and other Academy scientists to focus on a very specific part of land along Barrett’s Run, in the Cohansey River watershed in New Jersey. There, the American Littoral Society, an environmental nonprofit, is currently restoring a seven-acre tract of farmland to a grassy meadow in hopes that their efforts will reduce sediment and improve water quality.

Currently, Academy scientists are assessing the impact of the new meadow by installing traps up and down the slope of the field that will measure the amount of fine sediment running off during storms. If successful, the meadow vegetation will hold onto the soil, slowing water flow and increasing infiltration into the ground. — Alissa Falcone

How do Academy scientists know exactly where to observe water quality or test sediment conditions near riverbanks throughout the entirety of the Delaware River Basin? By “hiking” the streams from the comfort of their offices, using any laptop.

StreamHiker, an Academy-developed watershed analysis tool, evaluates environmental conditions along and near a stream or river at the “reach” scale, or where monitoring efforts are conducted. So far, DRWI researchers have used StreamHiker to choose sites for sampling and examine environmental conditions at project sites and potential sampling sites. In the future, StreamHiker will offer statistical models to predict stream temperature at unmonitored reaches and simulate changes due to land development and climate change scenarios.

“Our goals are for watershed scientists, modelers and managers to incorporate the accessibility of data and analytical processes that StreamHiker facilitates into their work, while also leveraging StreamHiker’s flexibility of data scaling to make innovative watershed models and tools,” says Alex Waldman, StreamHiker’s lead programmer, GIS manager and watershed modeler.

StreamHiker isn’t limited to one geographic location or institution. The project is open-sourced, meaning it is accessible to anyone, anywhere, no matter what body of water or environment they want to investigate.

StreamHiker is managed by Waldman and Jerry Mead, section leader of watershed and systems ecology and assistant research professor in the College of Arts and Sciences, with contributions from Scott Haag, database administrator. Mead developed the algorithm as a post-doc in 2006, but StreamHiker has since evolved into a complete software package after Waldman became involved with the project in 2013. The team has applied for NSF funding to grow StreamHiker’s reach and capacity even further. — Alissa Falcone

The Academy developed a computer model called StreamHiker for evaluating environmental conditions along a stream from a laptop.

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Many salamanders need water to breathe through their moist skin, so salamanders typically found by water can serve as indicators of water quality. While most states lack monitoring programs for stream salamanders, Academy scientists hope to change that by using their assessments of salamanders in the Delaware River watershed to create an index of stream health, much like how researchers use fish.

“We’re trying to understand what habitat features are important to salamanders in the Delaware and which ones are not; and for the features that are important, we’re trying to quantify them,” says fisheries coordinator David Keller.

The researchers visit different clusters of the Delaware River watershed to develop methods to assess salamander abundance. Sometimes, the work can be as backbreaking as repeatedly lifting rocks to find hiding salamanders.

“By the method we’re using, we’re not able to catch all of the salamanders in a given area. What we are able to do is to get an estimate of the relative density of animals in a given area by using CPUE, or catch per unit effort,” Keller says.

Each grouping of the sites will, in theory, show how salamanders are responding to anthropogenic stress, which can vary by site. Stormwater runoff is prevalent in Philadelphia, whereas agriculture is the main stressor to the environment in the Brandywine-Christina area. It’s a lot of ground (and rocks!) to cover, but Keller hopes that the work will give scientists another tool for monitoring water quality.

— Alissa Falcone

The Delaware River Basin is under attack from a foreign enemy: Japanese knotweed (Fallopia japonica), a non-native invasive species, has been covering a lot of ground, and water, and wreaking havoc on its environment.

Though the bamboo-like plant seems harmless with its heart-shaped leaves and small white flowers, Japanese knotweed is known as the “Attila the Hun” of the plant world because once it invades, it’s capable of much damage. The plant grows quickly and densely, crowding out native streamside vegetation and worsening erosion and sedimentation. It’s incredibly hard for humans to limit its growth, let alone get rid of the plant altogether.

“A lot of money is spent on stream bank restoration, which often includes removal of invasive plant species, but Japanese knotweed is very difficult to eradicate. It reproduces quickly from seeds or roots, and only a small root fragment is enough to regrow a population or travel downstream and colonize a new area,” says Kathryn Christopher, a staff scientist researching the invasive plant.

Christopher and her research partner, Derron LaBrake of Wetlands & Ecology Inc., have created a pilot study to research the effect the plant has on insects in the water, and how insects interact with it versus native plant species. She hopes to start a framework for other, more intricate questions regarding knotweed and stream conditions.

In January, the team deployed leaf packs, or mesh bags stuffed with leaves, into several area streams. The packs were collected over several weeks through February and early March for the researchers to examine the insect communities that have colonized the leaves.

“We are looking to see if the insects show a difference in preference between native leaves and knotweed,” she says. “We are trying to better understand the effects of knotweed on stream ecosystems so that management plans can be better tailored for specific sites, with hopefully better results.” — Alissa Falcone

Salamanders are sensitive to habitat loss and stream impairment, and existing protocols for their study are inadequate.

— Alissa Falcone
Neighborhood factors accounted for about 12 percent of the risk of diabetes when adjusted for respondents’ age and sex, researchers found.

A new Drexel study by professors Longjian Liu and Ana E. Núñez published in November 2014 in the journal Advances in Preventive Medicine, found that living in a disadvantaged neighborhood may play a critical role in a person’s risk of the disease. The researchers determined that diabetes rates could drop by 12 percent if the neighborhood environment was improved. Another nearly 12 percent of risk correlated with education.

“To often, we focus exclusively on the individual in solving the problem; here we found that we also need to focus on the healthiness of the community if we want to improve overall health and ultimately decrease health care costs,” Núñez says.

To conduct their study, Liu and Núñez developed an indicator of people’s physical and social environment based on their answers to questions about the availability of healthy food, use of local recreational facilities, and helpfulness of neighbors and other factors, in addition to poverty level.

The survey also asked more than 17,000 participants in 46 Philadelphia ZIP codes questions such as whether they were overweight or obese, their physical activity, fruit and vegetable intake, age, sex, race/ethnicity and smoking status.

P H I L A D E L P H I A N S know that when it comes to diabetes, geography matters. The city has the highest diabetes rate among the nation’s large cities, as well as the worst health status overall of any county in Pennsylvania.

For public health researchers at Drexel University, that makes Philadelphia a prime location to study how neighborhood and community-level factors — not just individual factors like diet, exercise and education — influence people’s risk.

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shown that children who are minorities or whose families are low-income tend to get diagnosed at a later average age. The institute is also involved in research developing more ways to reach underserved minority and low-income communities, such as through black churches, and working on a pilot study funded by Pennsylvania’s CURE program to explore screening in child-care centers.

EARLY SIGNS
Autism screening asks parents to answer questions about normal child behavior to assess their child’s risk of autism. Typical questions include: If you point at something across the room, does your child look at it? Does your child play make-believe? Is your child interested in other children? Does your child show you things to share them with you?

“How can we ensure that all children have access to the best possible services to help them develop to their fullest potential? Getting the right on-time screenings, early diagnosis and early intervention to those who need it across the entire population is the goal.”

-Diana Robins, associate professor in the A.J. Drexel Autism Institute
Public policy addressing post-traumatic stress disorder has a strong focus on military personnel, but what about civilians?

Post-traumatic stress disorder (PTSD) has been described as a “wound of war,” and is often associated with military veterans. But the disorder actually affects a much larger population of non-military civilians in the United States and many non-combat trauma exposures, such as sexual assault, carry a higher risk for PTSD. However, federal legislation falls short in addressing that fact, according to a new study authored by Jonathan Purtle, an assistant professor in the School of Public Health.

Recently published in the Journal of Traumatic Stress, Purtle’s analysis of federal legislation addressing PTSD revealed that an overwhelming majority of the language showed efforts were targeted exclusively at military personnel — more than 90 percent of mentions of PTSD in the bills were intended to address consequences of combat exposure.

That emphasis does not match with the frequency of PTSD in the U.S. population. Many types of traumatic events can cause PTSD — violent injury, car accidents, surviving life-threatening diseases, sexual assault and natural disasters, as well as combat exposure. One-time and chronic exposure to traumatic events can also cause traumatic stress, involving some symptoms common in PTSD, without matching the full pattern of diagnostic criteria for PTSD.

Purtle’s study is the first to examine how public policy has been used to address psychological trauma and PTSD in the United States, providing a glimpse of how lawmakers might think about these issues.

“It’s almost as if lawmakers didn’t want to suggest that PTSD was also a disorder among civilians,” Purtle says. “This gives a sense of how elected officials at the federal level might think about the dimensions of this problem, and shows that it doesn’t match up with what’s known about who gets PTSD.”

PTSD first became known through cases involving people who’d been in combat, which has influenced how it’s handled as a public policy issue.

The region of the country where drug users get high — whether they live in California or New York, where different drugs are dominant — can impact health outcomes.

It’s known that local drug markets influence what drugs are available to users and how users prepare and administer those drugs — which in turn impacts users’ risk behavior and health outcomes.

However, most studies on injection drug use in the United States have focused on persons who inject drugs (PWID) living on the East Coast. School of Public Health Assistant Professor Alexis Roth wants to bring more West Coast data into the mix.

Before joining Drexel, Roth worked at the University of California, San Diego. There, she conducted analyses that identified patterns of polydrug use among PWID living in that region. Polydrug use is when two or more drugs are used at the same time in combination or on the same occasion. She aimed to identify risk behavior and health outcomes associated with different patterns of polydrug use and to see how these patterns differed from those reported on the East Coast.

“The practice of polydrug use is poorly understood,” Roth says. “Often, PWID are labeled as either polydrug users or not. However, drugs can be combined either simultaneously (cocaine and heroine mixed together in a speedball) or sequentially (a shot of heroin to come down from a cocaine binge).”

Roth and colleagues identified two main drug-using classes: heroin injection and methamphetamine administered via multiple routes. Membership in each class was associated with differing odds of risk behavior and health outcomes. The makeup of these classes was also different from those found on the East Coast.

The reason for these differences is a matter of supply, says Roth. On the East Coast, white powdered heroin and powder cocaine are common. While on the West Coast, black tar heroin and methamphetamine dominate.

Since joining Drexel, Roth has continued this
WHAT CAUSES people to develop eating disorders? Research has consistently supported the view that disordered eating stems from some combination of psychological and social factors. But a group of researchers at Drexel, led by Psychology Professor Michael Lowe, suggests that childhood weight gain may play a bigger role than previously thought.

The teams’ recent findings suggest that women with a tendency for excessive weight gain during development may be more susceptible to developing an eating disorder. The research evidence revealed that women with bulimia nervosa were heavier than their peers during adolescence — before they developed an eating disorder.

They also found that women who go on to develop anorexia during adolescence are heavier than their peers from grades one through six.

“The weight gain that eventually results in obesity sometimes starts early in life,” Lowe says. “On one hand, the best approach is to prevent weight gain because it is so hard to treat once it is established.”

But, warns Lowe, if you place too much emphasis on weight — especially during adolescence when girls are especially sensitive about their weight and appearance — you could inadvertently spur unhealthy dieting and rapid weight loss, which could contribute to an eating disorder. “So there is a balance that needs to be struck, but few people are aware of this dilemma or how to cope with it,” says Lowe.

CROSS_CULTURES

On the East Coast, white powdered heroin and powder cocaine are common. On the West Coast, black tar heroin and methamphetamine dominate.

_CHILD OBESITY

Can Philadelphia’s massive initiative to provide mental illness literacy teach our communities to be kinder?

_MENTAL ILLNESS

There is a wildfire of mental health awareness and prevention spreading across the nation, and Drexel’s Nancy Epstein wants us all to help fan the flames.

One widespread program is “Mental Health First Aid,” a mental health literacy approach that was first developed in Australia in 2000. It trains people in public service roles — from librarians to public safety workers to health professionals and faith leaders — about mental illness and provides them with tools to help those in need.

Philadelphia’s Department of Behavioral Health and Intellectual disAbility Services adopted the program in 2012 and asked Epstein to evaluate it.

In Philadelphia, more than 8,000 people have received the training, with a long-term goal to train 100,000.

“This program is happening in every state — more than 250,000 people had been trained in the United States, and Congress had funded 120 new MHFA projects around the country,” says Epstein. “This is now a ‘happening’ national public health initiative.”

As principal investigator of Philadelphia’s evaluation study, Epstein is looking at the impact of the program on people’s behavior and attitudes, with the goal of determining whether it results in the kind of early intervention that allows individuals to get help before problems escalate into addiction, self-harm or violence.

“In any publicly funded program, it’s essential to have a strong evaluation to know what’s happening,” says Epstein.

Epstein and her team have surveyed more than 800 trainees since early 2014 and though the study is still in its early stages, she says what she’s found so far is “striking.”

Seventy-two percent of those surveyed reported using what they’d learned at the training. At six months, 53 percent reported using it in the workplace, 38 percent used it to help family members, 37 percent used it to help friends, and 32 percent used it to help themselves. Fifty-one percent reported helping someone get help.

Epstein’s colleagues, Amy Carroll-Scott and Felice Le-Scherban, are currently designing additional studies of the program’s “ripple effect” across the city.

EMPATHY_EDUCATION

“Without fail, every person I interviewed said [the training] was making a difference in their lives,” says Epstein.
Hospital-based violence intervention programs can save a healthcare system millions, according to a first-of-its-kind study.

The best time to stop cycles of violence is at the moment of crisis, when tensions are highest. Usually, that means inside the emergency room.

Nationwide, more than 25 hospitals have adopted intervention programs to prevent violent injuries before they happen.

Through hospital-based violence intervention programs (HVIPs), teams of medical professionals and social workers step in at a critical moment in a patient’s life — the period following a violent injury such as a gunshot or stab wound — with case management, counseling and other services to help them escape the cycle of violence.

As these programs have grown, so too have reports of their success. There is evidence that HVIPs prevent violent reinjury and perpetration, reduce aggressive behaviors and improve employment, education and healthcare utilization among program participants.

And, according to a Drexel research team, not only do these programs transform lives, there can be significant cost savings in various sectors including health care and criminal justice.

The team reports in the February issue of the American Journal of Preventive Medicine that an HVIP serving 90 clients could result in cost savings from tens of thousands of dollars and up to about $4 million in a five-year period.

This is the first systematic economic evaluation of a hospital-based violence intervention program, and it’s done in a way that can be replicated as new evidence emerges about the programs’ impacts across different sectors,” says Jonathan Purtle, who was lead author of the simulation study.

Attaching dollars and cents to HVIPs is important because many HVIPs lack a sustainable funding source.

“Even if the intervention cost a little more than it saved in dollars and cents to the health care system, there would still be a net benefit in terms of the violence it prevented,” says Purtle.

Could exposure to a rare metal in the workplace explain the occurrence of a mysterious inflammatory disease?

As computers and smartphones become bigger factors in our lives, more workers are being exposed to a toxic metal that was once limited mostly to the workplaces of welders and manufacturers of atomic bombs: beryllium.

Nowadays, beryllium exposure is more widespread because it’s used in the manufacture of computers and cell phones, says Igor Burstyn, an associate professor of environmental and occupational health in the School of Public Health.

In a 10-year study funded by the Alberta Health Foundation for Medical Research and the Canadian National Sarcoidosis Organisation, he and other researchers looked at whether beryllium was causing new cases of sarcoidosis, a rare but serious inflammatory disease.

Burstyn and researchers from the University of Alberta, University of Calgary and Alberta Ministry of Health identified 665 cases of sarcoidosis from patients who were diagnosed in Canada from 1999 to 2005. Patients were evaluated through a questionnaire and DNA extraction.

Researchers also calculated patients’ level of beryllium exposure based on their type of job and how long they were employed. They also looked for patients with a genetic mutation called Glu69.

They found that beryllium exposure on the job is a factor in some cases of this disease, especially if patients had the Glu69 mutation, which made them more sensitive to beryllium.

“This gene does not make you sick. It’s not the mutation that will give anybody the disease. It’s only a mutation that makes you vulnerable,” says Burstyn.

This could lead to more warnings, prevention and more accurate diagnosis for people who work in these fields, he says.

Sarcoidosis can lead to fatigue, joint pain, blurry vision, shortness of breath and arthritis.
**THE PRENATAL RUNAROUND**

A hypothetical case study illustrates the challenges faced by low-income pregnant women in reaching places for prenatal care.

As a researcher and practicing nurse, Drexel’s Joan Bloch has access to a lot of data. And in that data is a shocking statistic — there is a stunning two-fold racial disparity in infant mortality in the city of Philadelphia. But, why?

“As a nurse, I try to make sense of what the data may mean based on my experiences caring for real pregnant women in Philadelphia,” says Bloch, who is an associate professor in the College of Nursing and Health Professions with a secondary appointment in the School of Public Health. Her research explores the challenges faced by low-income pregnant women who must rely on public transportation.

“I wanted to delve more deeply into what does travel really entail for women who have babies in communities that have a really high rate of preterm births,” says Bloch.

Bloch and her collaborators combined large-scale geographical map data with a hypothetical “case-vignette” of a low-income pregnant woman in a Philadelphia neighborhood with high preterm birth rates.

“The simulated case subject was vetted through an expert panel of prenatal care providers who said ‘she’ was a typical example of what they see in their patient population,” she says.

The mapping and case-vignette work produced some shocking numbers:

This hypothetical mother-to-be would need to make 25 visits to different facilities to get prenatal care, traveling nearly 180 miles over more than 19 hours.

The blame shouldn’t necessarily be placed on the flaws of the city’s public transportation system, says Bloch. It’s the number of different facilities a pregnant woman must visit that compounds the problem.

“We have to create more efficiencies — every neighborhood needs a one-stop shop for moms as they take care of themselves, their babies and their children,” says Bloch. “We have to make it less difficult.”
Jennifer Taylor was researching firefighter injuries when she stumbled across data revealing an alarming number of assaults by patients against paramedics and EMTs. Now she’s building a case for policy changes to protect medics from physical and psychological job hazards.

Twice in her life, Jennifer Taylor has needed to call 911 because a food allergy put her into anaphylactic shock. “I would have died if I wasn’t resuscitated,” says Taylor, an associate professor of environmental and occupational health in Drexel’s School of Public Health.

When any of us dials 911 for medical reasons, we’re confident an emergency medical technician (EMT), trained in basic life support, or a paramedic, who can perform more advanced procedures such as inserting breathing tubes, will show up quickly. For Taylor, that’s what happened.

“It’s a great social value: If you call 911, someone will come to you,” she says.

But consider that 911 experience from the perspective of the EMT or paramedic. When Taylor called, she was helpless, experiencing a life-threatening emergency. But the medics who jumped into an ambulance and headed toward her likely had no idea what they would encounter. They’re entering private homes, sometimes where residents are living on the very edge. Sometimes, what’s waiting are people who are potentially dangerous, because they’re delirious, desperate, on drugs or just plain belligerent. The unfortunate outcome in such a situation might be an injured medic.

Taylor’s area of research is injury prevention and control, and she uses her knowledge to address safety issues in health care and first responder industries. With Federal Emergency Management Agency grants of $870,000 in 2010 and $1 million in 2013, she’s spent the past five years studying line-of-duty nonfatal injuries in members of the fire service in order to understand what it would take to create a national registry of firefighter injuries.

As an epidemiologist, she studies large datasets for patterns and correlations. And so it happened that while she was examining 10 years of firefighter, paramedic and EMT injury shared with her by the Philadelphia Fire Department, she stumbled across something unexpected.

A striking number of first responders were reporting being assaulted while on a call. At first, Taylor thought the injuries were gender related: 22 percent of women’s injuries were caused by being struck by a patient, compared to just 9 percent of men’s.

“We didn’t understand why women would be reporting that type of injury more than men,” she says. Were women easier targets for aggression? Were men less likely to report an assault?

To find the answer, she and her colleagues did something simple: “We asked them.”

But as discussions unfolded, the first responders pointed out an important fact that sent Taylor’s investigation into an entirely new direction: Most of the women employed by the Philadelphia Fire Department are not firefighters but rather paramedics and EMTs. When it comes to a preponderance of “struck by” injuries, the controlling factor was not gender-related.

“It’s all about the occupation,” Taylor says of her “a-ha!” moment.

She reorganized the data and discovered that medics are twelvefold more likely than firefighters to be assaulted.

“We think of cops being in a hazardous profession,” Taylor points out, “but not EMTs and paramedics.”

When a medic gets injured, nothing

In her conversations with emergency personnel in the Philadelphia Fire Department, Taylor heard many stories of medics being unexpectedly harmed. One paramedic, for example, told Taylor about an incident where a patient was sitting on a stretcher when he “just comes up and punches me in my mouth with everything he had.”

The descriptions of assaults experienced by medics in the fire department’s own reports read like police reports from a brawl: “struck by patient on head resulting in laceration above the eye;” “was punched in the face by a drunkard;” “was tackled by a large man;” “patient head-butt[ed] EMT on the jaw;” “in transport patient became combative.”

Taylor also discovered a sad reality: Along with occasionally being hit by the people they’re trying to help, many medics feel emotionally battered by their job.

In Philadelphia, 200 paramedics operate 40 advanced life-saving ambulances, each staffed with two responders. About 20 of those vehicles are active at any point. The volume of work is astonishing. In 2011, emergency medical services workers went on more than 337,000 runs. That comes
out to nearly 1,000 runs a day.

“Our department is overworked and overstressed; we have a lot of calls,” one female paramedic told Taylor. “And I understand that they need to get the units back out on the street … to get to these people, or else it becomes an embarrassment to the city if something was to go wrong.”

The pressure results in stress, burnout and, by extension, some of those injuries, since the hectic pace leaves little time to establish situational awareness. “We’re not giving our medics the rest they need to do this job,” says Taylor.

Meals, usually poor-quality ones, are scarfed down quickly between runs, during which the medics often deal with traumatic events and might be exposed to people living in desperate conditions. What’s the salary for a job this challenging? A mere $35,000 or so for an EMT and about $42,000 for a paramedic.

One obvious solution would be to increase the department’s headcount, but no national standard exists for how many paramedics a city should employ per 100,000 population. “That doesn’t help a city government or a fire department when they’re trying to say, ‘How many paramedics should we have?’” says Taylor.

Other practical improvements to improve on-the-job safety would entail giving the medics better information going into a scene — Is there a shooter? Is this a house where drugs are sold? — as well as providing training on how to manage a combative patient and de-escalate a scene.

“We’re dispatched in way too many incidents that we have no idea what we’re walking into,” a male EMT said to Taylor. “When we ask dispatch what it is, they’re very vague about — ‘Oh, I don’t know. [It was] sent by police.’ That’s what we walk into every day.”

Police officers are taught how to handle dangerous encounters, but not paramedics and EMTs. A female paramedic noted, “Everybody forgets that we’re in the same violent situation because we’re dealing with the same people, but no one teaches us how to protect ourselves.”

Many medics expressed that they felt undervalued by their leadership and the public, particularly in comparison with the firefighters they work next to in their department. “When a firefighter gets injured, they go all out,” said a female paramedic, describing the resources her bosses marshal. “When a medic gets injured, nothing. … No one visits us. And that’s how it is.”

Joe Schulle, president of the Philadelphia Fire Fighters and Paramedics Union, can fire off several suggestions for mitigating the issues faced by medics. He would like to see placards on EMS vehicles like the ones in Canada that tell people it’s a felony to assault a first responder, as a reminder that medics fall into that category and are just as important as firefighters and police officers.

“They don’t feel anybody cares,” Schulle observes.

In addition, the medics need a chance to recover from the exhausting pace and sometimes traumatic runs. “When you talk about what paramedics experience,” he says, “there are very few mechanisms to deal with the stress.”

He gives an example of a unit that responded to a disturbing car accident that killed an entire family: “Twenty minutes later, [the medics] were required to be back in service.”

REMAKING THE MISSION

One of the most intriguing solutions that Taylor posits has
to do with the aforementioned community expectations: the idea that if you call 911, a medically trained person will soon appear.

In practice, this policy invites regular overuse of the system by people who don’t feel that they have anywhere else to turn. Twenty-six percent of Philadelphians live below the poverty line, with almost half of those in “deep poverty,” meaning a family of three that brings in only $10,000 annually. According to a 2014 report from the Philadelphia Department of Public Health, nearly 20 percent of adult residents lack health insurance. Underserved and low-income populations call for paramedics when they have fevers, need prescriptions picked up or want assistance getting into bed.

“People think we’re there to be their taxi service,” one EMT reports.

While those events require valuable resources that should be reserved for emergencies, they reveal a powerful underlying attitude: Employees of fire departments are trusted. People readily invite them into their homes. What if there were a way to harness that trust to improve community health?

The model is called community paramedicine, and it entails expanding the job definition of paramedics. Rather than only showing up at the scene of a medical emergency and providing transportation to a hospital, the medics become an extension of the health-care system, providing proactive referrals for people in need of other, long-term services.

Ideally, community paramedicine would identify problems at an early stage. As Taylor explains it, “Medics can figure out what patients need and then connect them with the services or provide that service right there.”

Community paramedicine can be employed in urban areas where lack of knowledge about options causes people to let health problems fester or to rely on familiar services, like 911, when another is more suitable.

The model is already being used elsewhere in the United States, including at Christian Hospital, a 13-hospital system in St. Louis with the busiest emergency room in Missouri.

“We were not taking care of these people to the best of their potential,” Chris Cebollero, chief of Christian’s EMS division, says of the area’s low-income population. “We were taking care of the episode, but not the problem.”

Cebollero sees clear benefits for the EMTs at Christian Hospital. “A lot of our folks get into this career field because they want to help people,” he says. “There are times when they get frustrated by their lack of ability to get people where they really should be. Now we’re getting people where they need to go.”

The hospital paid for the needed additional training by moving money around, but Cebollero notes that by reducing the use of expensive ambulances to repeatedly transport what he jokingly calls “members of the EMS loyalty program” to the ER, the hospital could save money in the long run.

In Philadelphia, where the fire department’s structure is rigidly traditional and its budget is controlled by City Council, change will require political will and persuasive arguments.

Taylor, for her part, is actively pursuing funding to assess every medic and firefighter in the Philadelphia Fire Department for stress, burnout and other indicators of physical and emotional labor.

In the meantime, “The number of calls is increasing, but the number of medic units isn’t,” says union president Schulle. “You just can’t keep adding workload.”

ALWAYS_ON_CALL

01 Medic 7 is an ambulance crew stationed inside Engine 43 in the Center City section of Philadelphia. In Philadelphia, all ambulances and firefighters are co-located in firehouses and may encounter similar dangers and stresses on the job. 02 Like firefighters, medics sometimes have to don protective gear for calls to dangerous situations. 03 Colleen Teefy is one of the paramedics with Medic 7. 04 Filomena Almodovar is an EMT with Medic 7. 05 A typical evening as a first responder in the city. 06 Cathy Ramer, a member of the firefighter crew, reads a medic bag for a colleague. 07 Unlike police officers, medics aren’t given training on how to protect themselves in violent situations.
Although malaria has been virtually eradicated from the United States since the 1950s, the disease remains deadly elsewhere in the world. The World Health Organization estimates 600,000 people die of malaria every year and hundreds of millions are infected.

Malaria’s growing resistance to antimalarial drugs — derived from a Chinese herb and other compounds — makes it all the more important to find new pathways to combat the disease, especially in developing countries.

“If that fails, and we don’t have anything in the pipeline, we’d be in a dire situation,” says Drexel’s Akhil Vaidya.

Malaria-causing Plasmodium parasites grow within human red blood cells and are transmitted from person to person by mosquitoes. On infection, the parasite induces changes in the host cell membrane so that more nutrients are taken in, which triggers an increase in sodium concentration within red blood cells. However, the parasite keeps its own sodium levels low with the help of a protein, which pumps sodium out of the parasite. A class of antimalarial compounds known as spiroindolones affects this process and is currently being tested in clinical trials. However, the search for new classes is essential in the face of emerging drug resistance.

Recently, Vaidya led an international team in discovering a new class of drug compounds that could lead to potent new treatments. Their discovery was reported in Nature Communications.

The compounds they identified, called pyrazoleamides, halt Plasmodium cells’ ability to pump out sodium.

The researchers observed the parasite’s cells swelling to twice their original size before bursting. The parasites were stopped in their tracks and unable to reproduce.

“The results of the study confirm that targeting sodium balance in Plasmodium is a promising approach for developing new antimalarial drugs,” says Vaidya, the study’s principal investigator.

“Further research is needed to precisely identify the molecular target of the compounds and to determine whether these can be developed into other effective antimalarial drugs.”

The research from this global team was supported by Medicines for Malaria Venture, an international nonprofit, and the U.S. National Institutes of Health.

“We still don’t have a drug that can be used tomorrow, but the pipeline is there,” Vaidya says.
“The results of the study confirm that targeting sodium balance in Plasmodium is a promising approach for developing new antimalarial drugs. Further research is needed to precisely identify the molecular target of the compounds and to determine whether these can be developed into other effective antimalarial drugs.”

—Akhil Vaidya, professor of microbiology and immunology and director of the College of Medicine’s Center for Molecular Parasitology
A ‘C. DIFF’ VACCINE?

A vaccine successful in animal models could protect humans from the dangerous and increasingly common “C. diff” infection.

“C. diff” is an antibiotic-resistant bacteria that causes life-threatening intestinal inflammation once it takes hold. Now, a research team from the College of Medicine could hold the key to preventing disease caused by *Clostridium difficile*, or “C. diff” for short.

Problems occur when healthy gut flora are overwhelmed by *C. diff* populations during or after antibiotic use, and it can make people very sick. In fact, the infection kills thousands of Americans every year and warrants further research of their study were published in the *Journal of Internal Medicine*. Findings from their work, funded by the Department of Defense, was patented jointly by Drexel University and the University of Pennsylvania and then licensed by Inovio Pharmaceuticals, a biomedical company in Plymouth Meeting, Pennsylvania.

C. diff is a common bug in hospitals and kills thousands of Americans a year. It’s no secret that we change as we age — we may shrink, we may need glasses and that spring in our step slowly becomes a creak. But we’re also changing on a sub-cellular level. Our microbiomes — the microbes that live on and within our body — are aging and changing, too.

Gail Rosen, an associate professor in the Department of Electrical and Computer Engineering, and her student Yeimin Lan, a doctoral candidate in the School of Biomedical Engineering, Science and Health Systems (BIOMED), have identified markers in our gut bacteria that give away our age, and in doing so, may show the pathway to explain the mechanisms behind some common age-related maladies.

Rosen and Lan took an electrical engineering approach to the research, with help from Andres Kriete, associate director for graduate studies and academic operations in BIOMED. Their work was published in 2013 in *Microbiome*.

Specifically, Rosen and Lan looked at the bioflora of patients associated with an inflammatory bowel disease study and differentiated what factors indicated a patient’s age.

They found that the bioflora in older subjects showed a number of factors: reduced activity of reductases, increased DNA damage, compromised stress responses and immune systems. They also found that the bioflora in older subjects synthesized less vitamin B12 than in younger patients.

“It’s well known that the elderly are always deficient in B12 and that they should be taking B12 vitamins,” Rosen says. “This is saying that the microbiome mechanism [for B12 production] may be decreasing as we get older.”

They can now use these selective factors to guess the relative age of an individual’s genetic sample with an “area under the curve” accuracy of 70 percent using the receiver-operating characteristic curve method, which is a way of measuring how well a test correctly classifies information.

Given that people age at different rates, and that our microbiomes vary depending on our environments, 70 percent area under the curve is remarkable. This is the first study of its kind that indicates that aging has a detectable effect on the adult microbiome.

“It’s well known that our eyes get dryer and we don’t generate as much lubrication as we age,” Rosen says. “Could this be affecting our digestive tract and how it hosts the microbiome?” It could be that these age-related changes are involved in a giant feedback loop, and that by understanding the point of age-related breakdown, some age-related body changes can be remedied.

**ELDERLY BIOMES**

This chart uses the statistical data analysis method known as principal component analysis (PCA) to demonstrate the relationship between the age of individuals in the study sample and certain “selective factors” in their genes associated with aging, such as DNA damage and B12 deficiency. Each dot represents an individual in the sample, marked by a color that corresponds to their age (except for red which indicates 80 years and older). There is a clear differentiation between the oldest and youngest individuals and gradual progression from old to young, indicating that the microbiomes in the elderly behave differently from those of young people. There is also wide overlap among the middle-aged (as is to be expected because individuals age at varying rates).
Since 2008, a handheld brain-scanning device called Infrascanner has been saving lives on the front lines. But, like most technologies, it periodically needs an upgrade.

Drexel engineers have been working with InfraScan Inc., a Philadelphia-based medical technology firm specializing in brain injury diagnostics, to design this life-saving device. Recently the team was invited to design the next-generation model that the military can use to assess head injuries in the field.

The upgrades call for adding more tissue-scanning capabilities and field-testing protocols to help first responders diagnose and triage traumatic brain injuries — the wounds that account for nearly half of all combat deaths.

“Patient outcomes can improve significantly if treated within the first hour after an injury — known as the ‘golden hour,’” says Baruch Ben Dor, president and CEO of InfraScan. “The early identification of a brain hematoma, swelling and decreasing tissue oxygen levels can play a significant role in facilitating transportation of critically injured patients to facilities, which can both verify Infrascanner’s early screening and offer immediate surgical intervention.”

Infrascanner, the device, which uses near-infrared light to detect blood pooling in the brain, will be modified to also pick up local changes in tissue oxygenation — a more deadly outcome of a head injury. The Drexel engineers, who designed and implemented the algorithms that went into the original Infrascanner when it was developed in the mid 2000s, will adjust them to also pick up signs of edema — swelling of the brain.

In addition to adding the new programming, the team will also help give Infrascanner a more rugged hardware design so it can stand up to use in the field.

InfraScan signed a $3.7 million contract with the research centers of the U.S. Marine Corps and the Navy to redesign the device, which has been used by the military since 2008 and has been commercially available since 2013.

The two most common forms of dementia may have more in common than current diagnostic guidelines allow.

Two of the most common forms of dementia — Alzheimer’s disease (AD) and vascular dementia (VaD) — have traditionally been viewed as separate clinical syndromes. However, the two diseases share a number of similar pathological markers and autopsy data often indicates “mixed” AD or VaD results.

New research led by David J. Libon in Drexel’s College of Medicine suggests that AD and VaD have much more in common than current diagnostic guidelines allow.

Researchers at Drexel (in addition to Libon, there was Laura Brennan, Joel Eppig and Christine Nieves from Drexel’s Department of Neurology) and seven other universities analyzed 223 patients with dementia, who were seen at an outpatient memory clinic and diagnosed with AD or VaD. Participants were evaluated by a team of dementia specialists and underwent neuropsychological testing, appropriate brain scans and necessary blood tests.

The researchers found that dementia patients thought to be suffering from either AD or VaD could be sorted into distinct, very nuanced clinical profiles. Using a sophisticated statistical modeling procedure, the researchers were able to identify four distinct groups: moderate/mixed dementia group; mild/mixed dementia group; dysexecutive group with significant impairment in multitasking; amnestic group with profound memory loss.

The study was published last year in the Journal of Alzheimer’s Disease.

“We were able to determine that these two common forms of dementia are not wholly separate,” says Libon, the study’s lead investigator. “These shared characteristics should be taken into consideration both in the development of future AD and VaD diagnostic guidelines and in selecting patients for newly emerging medicine designed to treat dementia.”

“We were able to determine that these two common forms of dementia are not wholly separate.”

— David J. Libon professor in the Drexel Neuroscience Institute
A new Drexel study maps the brains of individuals with aphasia, an impairment of language common after a stroke or other brain injury.

The exchange of words in a conversation may seem unremarkable for most people. But, for people with aphasia, communication problems can make it difficult to work and maintain social relationships. Aphasia is an impairment of language that often happens after stroke or other brain injury.

A new Drexel study published in the journal Nature Communications provides a detailed brain map of language impairments in aphasia following stroke.

Assistant Professor of Psychology Daniel Mirman, the lead author of the study with colleagues at the Moss Rehabilitation Research Institute, says his team’s findings could help “improve our clinical understanding of aphasia and get new insights into how language is organized in the mind and brain.”

The researchers found that spoken language impairments vary along four dimensions or factors: semantic recognition (matching related pictures and/or words); speech recognition (telling “ba” and “da” apart, for example); speech production (making speech errors like saying “giraffe” instead of “giraffe”); and semantic errors (such as saying “zebra” instead of “giraffe”).

Next, the researchers determined how each of these impairments was associated with the locations in the brain damaged by stroke. They created a four-factor lesion-symptom map of hotspots in the language-specialized left hemisphere where damage from a stroke tended to cause deficits for each specific type of language impairment.

Studying the association between patterns of brain injury and cognitive deficits is a classic approach, with roots that go back to the dawn of cognitive neuroscience in the 19th century. Mirman and his colleagues have scaled up this approach, both in terms of the number of participants and the number of performance measures, and combined it with 21st-century brain imaging and statistical techniques.

A new compound developed by researchers in the College of Medicine could render breast and prostate cancer cells homeless. Without a place to “seed,” the cells eventually die in the bloodstream and don’t metastasize in the bone.

Unlike chemotherapy, the compounds aren’t toxic. “We aim to develop a medication that someone could safely take in combination with their normal standard of care,” says Salvino.

Clinical trials will focus on advanced breast cancer patients with evidence of metastatic disease. But both scientists believe their discovery could have implications for other types of cancer as well, particularly prostate cancer.

“This really is a translational scientist’s dream come true,” says Fatatis.
QUARANTINE IN QUESTION

A Drexel study suggests that the standard 21-day quarantine for individuals who might have been exposed to Ebola might not be long enough.

Twenty-one days. That’s the length of time an individual who has been exposed to the Ebola Virus should remain in quarantine. It’s a number set forth by the Centers for Disease Control and Prevention (CDC), but is it enough?

A new study suggests the 21-day quarantine period might not be sufficient to completely prevent spread of Ebola.

College of Engineering Professor Charles Haas looked at the murky basis for our knowledge about the virus, namely previous outbreaks in Africa in 1976 (Zaire) and 2000 (Uganda), as well as the first nine months of the most recent outbreak.

In both cases, data gathered by the World Health Organization reported a 2–21 day incubation period for the virus — meaning that after 21 days, if the individual hasn’t presented symptoms, it is likely that they are not infected or contagious. This is likely the reason for the Centers for Disease Control and Prevention’s 21-day quarantine period.

In his study, Haas looked more broadly at data from other Ebola outbreaks, such as the Congo in 1995 and recent reports from the outbreak in West Africa, where the range of deviation in the disease’s incubation periods was between 0.1 and 12 percent, according to Haas. This means that there could be up to a 12 percent chance that someone could be infected even after 21 days.

“While the 21-day quarantine value, currently used, may have arisen from reasonable interpretation of early outbreak data, this work suggests reconsideration is in order,” Haas says.

U.S. OUTBREAK

The more contagious and potentially deadly a disease, the higher the cost of making a mistake by prematurely releasing an exposed individual.

20/08
Duncan passes away, becoming the first victim of Ebola on U.S. soil.

10/12
A nurse who treated Duncan, Nina Pham, is diagnosed with Ebola, becoming the first person to catch Ebola on U.S. soil.

10/24
Pham is declared Ebola-free.

10/19
After 21 days, Duncan’s relatives are released from quarantine.

10/22
Vinson is declared Ebola-free.

10/13
Another nurse who was exposed to Duncan, Amber Vinson, boards a flight to Cleveland after developing a fever.

DATED_DATA

The CDC’s 21-day incubation period appears to be based on data from outbreaks in 1976 and 2000, which show less variance than data from recent outbreaks.

Sierra Leone
Liberia
Guinea

LOCKDOWN

Sierra Leone health officials check passengers transiting at the border crossing with Liberia in Jendema on March 28, 2015. The authorities in Sierra Leone started enforcing on March 27 a three-day lockdown to curb the spread of Ebola, with the entire population ordered to stay at home.
Almost all data has a “where.” Information is connected to a place and time and can answer questions about a city, a building or system. Through spatial analysis, researchers are able to understand where phenomena are, how they relate and what it may mean for policymakers.

At Drexel’s recently established Center for Spatial Analytics and Geocomputation in the College of Computing & Informatics, Tony Grubesic and Alan Murray are examining datasets with the tools of their field — geographic information science, statistics, mapping software — to influence deliberations on topics such as liquor privatization, urban lighting and safety, and the optimum number of rural airports.

“Most data has a spatial component,” says Grubesic. “We leverage that data to help decision makers craft better policy and to enhance operations.”

In a two-year project funded by the National Science Foundation, Grubesic and Murray used geospatial data to evaluate how alcohol outlets impact cities.

In Cincinnati and Philadelphia, they found different patterns of violence near on-premise alcohol outlets (like bars where the alcohol is consumed on-site) and off-premise outlets (like corner stores, where alcohol is consumed elsewhere). Crime rates were higher near places where customers of off-premise outlets gathered to drink, such as vacant lots.

They then asked what this might mean for Philadelphia if the city privatized liquor sales. Like many cities, Philadelphia has an ordinance that restricts alcohol sales near churches, schools, parks, etc. Alcohol availability is associated with violence, car accidents, child abuse and neglect, and youth suicide.

“Communities are trying to maintain standards,” says Grubesic. They found that privatization could lead to a nearly 60-percent increase in alcohol outlets, or an additional 1,115 outlets, given the city’s 200-foot proximity rule.

Crime Uncorked

Like many cities, Philadelphia has a proximity rule that bans liquor stores within 200 feet of any church, school, hospital or playground; geospatial analysis shows that the rule leaves plenty of room for more outlets.
Checkered Streets

The need for well-lighted urban streets is often at odds with the desire to curb light pollution.

Murray studied aerial photographs of a San Diego neighborhood at night using a series of high-resolution images from a drone camera — shooting not just once every six months or per year as many satellite mapping systems do, but daily — to observe how nighttime lighting varies across a neighborhood.

“Nighttime lighting enhances safety and security for a home or neighborhood as well as contributes to the charm and character of an area,” says Murray, “yet artificial light has been found to negatively impact humans and animals in a variety of ways.”

The images pinpointed where light posts are needed, and where light already being generated by businesses satisfies requisite needs, offering potential to save money while also contributing to public safety.

Flights to Nowhere

How do you balance transportation access with the cost of servicing remote areas?

Grubesic and Murray analyzed a federal program that pays commercial air carriers to provide service to rural airports. The program grew out of a temporary financial bridge created to maintain commercial air service in rural communities following 1978 airline deregulation, but it has grown into a multi-million dollar federal subsidy.

“The question is: Is there a way to ensure that the people and businesses who need this service still have some semblance of commercial air transport, but do it in a more efficient way?” Grubesic asks.

Through a spatial optimization model, they found that 99.7 percent of potential residents would still be served if the government defunded certain airports in areas that were already being adequately serviced, saving taxpayers nearly $22 million a year, with almost no impact on service.

**Patchwork**

In order to study the lighting over a San Diego neighborhood, researchers compiled individual images taken by aerial drones and pieced them together into a single map.

**Flights to Nowhere**

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**Propeller Planes**

By closing certain rural airports, taxpayers could save nearly $22 million a year, with almost no impact on service.
Zero-tolerance policies in public schools have led to huge numbers of kids arrested. Once a juvenile enters the criminal justice system, the ramifications are profound.

“Now these kids have criminal records, so good luck getting a job, many are barred from the military, their families may no longer qualify for public housing, or other forms of public assistance,” says Naomi Goldstein, an associate professor in the Department of Psychology in the College of Arts and Sciences.

Goldstein is part of a city-led effort to significantly reduce the rate of juvenile arrests in Philadelphia schools. She was tapped last year to evaluate the Philadelphia School Police Diversion Program, which was established in 2014 and fully operational in all Philadelphia public schools by this past May.

It’s a diversion program, which means that students committing lower-level offenses on school property who don’t have criminal histories are not to be arrested. Instead, they are diverted to prevention programming, a one-time second chance for these students.

It’s already showing impressive results.

“The objective was to reduce the number of school-based arrests by 50 percent annually,” says Goldstein. “By April 2015, arrests were down by 55 percent, relative to the same period during the previous year.”

At its launch in 2014, the program anticipated a 50-percent reduction in the annual arrest rate of juveniles in Philadelphia schools. As of April 2015, there has been a 55-percent reduction in the school-based arrest rate. Goldstein will evaluate the program over the next three years to determine its potential as a model for other cities.

$600,000 was awarded by the U.S. Department of Justice, Office of Juvenile Justice and Delinquency Prevention to support the Philadelphia School Police Diversion Program. The grant will fund, in part, Drexel’s evaluation of the program.

At a cost of $600,000, the Philadelphia School Police Diversion Program has reduced the number of juveniles arrested in the district by 55 percent in its first year. The program diverts students from arrest and instead provides them with educational and counseling services.

Providers told us about being physically assaulted, picketed at home, threatened over the phone and stalked around town. Providers’ children have been targeted at school, providers’ parents have been harassed in nursing homes and their spouses have been targeted at work,” she says. “Abortion providers live with a staggering amount and variety of targeted harassment.”

With nearly 90 extensive, in-depth interviews conducted across the country, their work is the largest study ever to investigate both what happens to providers and how the law can better help them.

Drawing on ideas from the interviews, the authors propose several legal and societal reforms that could improve the lives of providers, foremost among them is redefining targeted harassment as terrorism rather than protest.

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Can exposing educators to the arts reduce turnover, improve retention and instill leadership skills?

Administrative turnover is high in urban schools where principals face pressure to maintain student achievement despite inadequate staff, facilities and resources. One idea to improve the career pipeline involves exposing up-and-coming school leaders to the arts.

A program being implemented in Pennsylvania arranges for aspiring principals to meet at museums and other arts performance venues four or five times a year to develop their leadership skills through art. “Knowing how to be creative and innovative with limited resources is essential,” says Girija Kaimal. “The art becomes a metaphor for learning about yourself and learning about others. The goal of a responsible leader is to help [people] excel at what they do and facilitate their performance as a team.”

Kaimal works with Lehigh University College of Education professors George White (the principal investigator) and Jon Drescher for a program funded by the U.S. Department of Education that is designed to help recruit and retain principals in urban districts. The arts-based leadership learning sessions are facilitated mostly by teaching artists from the Maxine Greene Center for Aesthetic Education and Social Imagination. She’s currently evaluating the effectiveness of the five-year program in Pennsylvania’s Allentown School District.

The researchers recruited participants — around 14 people per year — from Allentown’s teacher pool. They chose those who are committed to staying in the district, because turnover tends to be greater when principals come from outside the community. “Principals might be transferred from school to school depending on staffing changes within an urban district so even if they want to stay in a school, they are often unable to stay long enough to make an impact,” Kaimal explains.

Over the course of the evaluation period, many of the participants have either been promoted to principal or have maintained their job as principal, Kaimal says, and some have stayed in the same school within the Allen-town district for at least two years.

**ARTFUL LEADERS**

Can attending a jazz ensemble or watching a mime performance inspire educators to think more creatively about communication, interpersonal learning, trust, collaboration and interpersonal support?
THE POVERTY CLIFF

Just when people manage to earn more money, they may find themselves worse off than before, according to new research.

That cliff effect — losing benefits in the transition out of poverty — was the focus of a policy report released by Drexel’s Center for Hunger-Free Communities late last year, based on Children’s HealthWatch data collected in Philadelphia from 2005 through 2013.

The analysis found that families who experienced a reduction of food stamp benefits (officially known as the Supplemental Nutrition Assistance Program, or SNAP) due to an increase in income were more likely to be food insecure or marginally food secure than were families who received a consistent level of SNAP benefits.

The report indicates other sacrifices in the family’s health and health care, beyond access to food. For example, families whose SNAP benefits were reduced were more likely to include a family member who was forced to forgo health care due to cost. In households who lost SNAP benefits completely due to increased income, young children were twice as likely to have foregone needed health care due to cost and more likely to live in a household that made trade-offs between paying for other basic living expenses to pay for health care.

The authors say solutions are simple: implementing paid sick leave and increasing access to affordable childcare, providing livable wages and developing strategies to help families stay off of benefit programs in the first place.

THE WALLS HAVE EYES

“A loss of benefits can have drastic impacts on a family...forcing them to return to benefit programs they worked so hard to leave.”

-Mariana Chilton, associate professor in the School of Public Health

INCREASED ODDS OF POOR HEALTH OUTCOMES

Consistent SNAP Receipt  Reduced SNAP Benefits  Loss of SNAP

A special room for unique research was built into the bottom level of Gerri C. LeBow Hall, the recently completed home of Drexel’s business school. Visitors entering it see a sign that reads “Behavioral Lab,” and what looks like a normal reception area.

But tilt your head up, and you may notice some things that seem out of place: a long white microphone and a black, dome-shaped camera fixture.

The lab is wired for audio and video recording, sound playback and, in one room, even climate control, allowing researchers from LeBow or elsewhere at Drexel to study how people act and react — all from a control room filled with screens, buttons and knobs.

The centerpiece of the lab is a large studio room that contains five different cameras mounted on the walls, plus a one-way mirror through which researchers can watch from the lab’s control room, unseen by their subjects.

The room allows researchers to study how people react to certain messages or stimuli. Instead of relying on surveys or written responses where people may or may not convey the truth about their reaction, researchers can watch their body language for clues: a lean, a slouch or a smile.

An experimenter can also pipe in sound or, if they wish, control the temperature in the large studio room. Some research has found that people feel warmer, more positive feelings as temperatures go higher, so researchers might test how temperature might affect business transactions. If you’re courting a new client, is it better to meet in Philadelphia during the winter or in Florida?

Outside of the main studio room, a smaller conference room with chairs arranged around a table allows for a different experimental environment. It, too, is monitored by cameras and a one-way mirror.

Even the lab’s reception area can be used as part of experiments. If you want to study how people react when they have to wait excessively long for an appointment, you can watch and listen from the control room as they squirm and groan.
How do you teach schoolchildren to research digital information when the classrooms have no computers?

That was the question researchers encountered at a K-8 public school in West Philadelphia when they tried to introduce students to a theoretical learning model called I-LEARN. I-LEARN helps children learn how to do research, especially by using digital technologies. It was developed by Delia Neuman, a professor in the College of Computing & Informatics. She and three co-researchers in the School of Education are studying the model’s effectiveness.

Not to be deterred by the lack of computers, the professors cobbled together discarded parts from around Drexel and installed the devices themselves. But they didn’t stop there.

“The digital divide isn’t just about access to computers, it’s about using them as tools,” says co-researcher Mary Jean Tecce-DeCarlo. “It’s about helping urban kids close the digital divide and helping teachers include computers in their curriculum, bottom-up.”

The professors found that I-LEARN successfully helped the students understand and complete research projects, both online and in general — and they learned more about how best to teach the model to teachers, too.

This year, the researchers took the I-LEARN model to a charter school in South Philadelphia to test it with older students. The students were asked to research ways to solve issues in their community.

Students used a school-wide questionnaire to understand what problems classmates identified in their neighborhood, like safety or crime, and then moved on to consider ways to locate information.

At that stage, the researchers got validation of their model when a fifth grader attending an assembly introducing local police officers immediately realized the officers could be sources of information.

“She saw the cross between the event with the officers and the connections she could make when using it for her research, just like a college student!” says Taryn Fletcher, the charter school principal.

At one school where the researchers introduced I-LEARN, kindergarten and second-grade teachers asked their students to use the I-LEARN model to complete a research assignment on the topic of “What makes Philadelphia special?” Students used their computers and other sources to retrieve information about Philadelphia and presented their findings in online portfolios, including their own colorful drawings and audio recordings to show what they learned about their cities and neighborhoods.
The recipe to bring a new product to market requires three ingredients: one part novel technology, one part robust management team and one part capital.

Most academics have expertise only in the first — which presents an obstacle to commercializing new discoveries. At Drexel, however, researchers have a resource most universities don’t: the Coulter-Drexel Translational Research Partnership Program.

Established nine years ago, the program helps researchers commercialize inventions that improve human health by equipping them to compete for and win proof-of-concept funds.

The format for project selection is similar to the reality TV show “Shark Tank.” First, researchers submit applications to an oversight committee at their university. Those who advance make an oral presentation and are given training to prepare to answer dozens of pointed questions from entrepreneurs, investors and others about market size, regulatory requirements, reimbursement strategies and competition. Winners receive grants and guidance to help develop their ideas.

“I think of the Coulter Program as the angel investor,” says Davood Tashayyod, business development director of the program. “Researchers have to do a pitch, and they have to convince a group of investors that they’re not investing in a bridge to nowhere.”

At Drexel, more than 40 projects — devices, diagnostics and drugs — have received money totaling about $5.54 million through the Coulter Program. Of those, a dozen have been licensed; meaning management teams are raising venture capital for additional pivotal FDA studies or a major corporation is capitalizing the project.

So far, one project has made it to market — FDA approval is a long process — and several other technologies promise to join it soon. The half dozen projects profiled here offer compelling ideas.

**INVENTED HERE**

_by Lini S. Kadaba / Illustrations by Harriet Lee Merrion_

**MIXING FUN AND PHYSICAL THERAPY**

Children with cerebral palsy (CP) often have a home regimen of physical therapy — and they usually have one word to describe the activities and exercises:BORRING!

But like many youngsters, these children were attracted to video games, including the Xbox 360 Kinect, where they use their body to control the games.

In theory, the full-body movement games could encourage children with the neuromotor disability to improve their physical function; but most patients found the games too challenging (too fast, distracting or noisy) to play successfully. What was needed was a game designed at their level that would challenge them to use their motor skills — while still being fun to play.

That led Drexel researcher Margaret E. O’Neil to an “aha!” moment.

“Wouldn’t it be great if we could change the parameters of this game?” wondered O’Neil, an associate professor of physical therapy and rehabilitation sciences in the College of Nursing and Health Professions.

The idea for Kollect was born.

O’Neil calls it an example of “stealth health.” The video game prototype, in which objects are collected, allows a therapist or parent to adjust parameters, such as the length of the game or which side of the screen the objects appear, in order to match gameplay to therapeutic goals, she says. The platform also records data and transmits feedback on patient progress to the therapist. In addition, it will have social networking aspects.

A $130,000 award from the Coulter Program allows for further game development as well as a rigorous patient study to test the platform.

“I don’t see anybody else filling this niche,” says co-principal investigator Paul J. Diefenbach, an associate professor in digital media who directs Drexel’s RePlay Lab for game research.

Already, a father in Germany who saw a video about the project asked how to purchase it for his toddler.

“It has the potential to impact so many people and change lives,” says Diefenbach.
The gold standard for treating Parkinson’s disease is far from perfect. Within five years of using the popular drug Sinemet or other L-dopa drugs, as many as 80 percent of patients develop dyskinesia, a severe, painful movement disorder. As a result, many Parkinson’s patients delay treatment and suffer through early-stage motor symptoms.

Now, Drexel molecular pharmacologist Sandhya Kortagere has designed a new drug that offers a promising alternative without the dyskinesia. “I think developing this compound has been the best challenge and most rewarding experience for me,” says the assistant professor of microbiology and immunology in the College of Medicine.

With a $100,000 grant from the Drexel Ventures Innovation Fund, Kortagere conducted tests of her drug on rodent models. Strong findings made her a prime candidate for the Coulter Program.

Called PCT-3010, it modulates both dopamine — too little causes Parkinson’s — and norepinephrine in the brain to reduce motor and other symptoms. It would give physicians an option to treat early as well as advanced symptoms of a disease that affects 6 million older people worldwide.

Kortagere’s experiments also showed that a daily dose of PCT-3010 can also improve some aspects of cognitive impairment that can characterize Parkinson’s disease. L-dopa, another current therapy, is known to worsen cognition.

“My compound when fully developed will help fill the existing treatment gaps,” says Kortagere.

PCT-3010 essentially has more selective signaling properties than current therapies. It activates the dopamine D3 receptors without desensitizing them and also inhibits noradrenaline transporters in the brain.

With a $100,000 award from the Coulter Program and other matching funds, Kortagere will run an experiment designed to validate the drug on higher species, such as dogs and macaque monkeys. As valuable, she says, is the guidance the Coulter Program provides on business aspects, including access to an adviser with experience in the pharma industry.

“Ultimately,” Kortagere says, “I felt like the Coulter Program wanted me to succeed. That was the message I got from the whole experience.”
The intelligent sensor, known as a piezoelectric finger (PEF), detects tumors by measuring small differences in tissue elasticity, that is, stiffness and softness. Tumors, of course, are harder than surrounding tissue.

“Human fingers have limitations,” says Shih, whose own battle with breast cancer further inspired the detector. “There is no handheld tool that can measure stiffness of any kind. If you want to find something at an earlier stage, you need some tool.

“This is a breakthrough,” she adds.

Currently, mammography is only 85 percent successful in spotting tumors — a figure that drops to 65 percent for women with dense breasts, Shih says.

Her test allows for an assessment in the operating room — and the chance to do the re-excision, if necessary, right then and there, which can reduce overall treatment costs and improve the patient’s experience.

The test uses a type of nanocrystals known as quantum dots (QDs), which the Shih’s have developed with high luminescence visible in near-infrared light. But the true innovation is that these QDs are made in an aqueous process that allows them to link to antibodies that can then attach to the receptors on the surface of cancer cells.

“We came up with a construct that can be very cost effective in linking to receptors,” she says.

The researchers envision that surgeons would remove a tumor with at least a 2-mm margin and then spray it with the antibody-functionalized quantum dots. Using a camera or goggles that detects near infrared, the surgeon would examine the tumor for luminescence — a sign of cancer cells on the surface.

“You don’t want anything to light up,” she explains. “You want a pitch dark screen.”

The Coulter Program awarded $240,000 toward this project. Shih and Shih’s third business idea is a low-cost, more accurate testing tool for C. diff, a common intestinal bacteria infection that can grow out of control in the gut of patients using antibiotics. Highly contagious, it is a growing concern in hospitals, where incidence has skyrocketed.

“Mortality is very high,” says Shih, noting that C. diff causes 14,000 deaths a year in the United States. The annual treatment cost is more than $3 billion.

Currently, a stool test is used to detect C. diff, but its effectiveness is only 60 percent. “That’s really like throwing dice,” she says. More sophisticated testing is very expensive and only available at a few hospitals.

Shih’s alternative is more accurate and specifies the presence of two specific toxins, allowing physicians to target treatment. Like her breast cancer scanner, this device relies on the piezoelectric technology.

Called a piezoelectric plate sensor (PEPS), it consists solely of a very thin, novel, man-made crystalline material that allows for greatly increased sensitivity. The device would have three PEPSs, two of them primed to detect the toxins produced by C. diff infection and one for a control.

Costing less than $10 per test, the tool could be adapted to check for other infections, including malaria or hepatitis.

“I think it can be employed where it is needed most,” she says. She and her husband have founded a small business, XELmagazine.org 83
Founded in 1891 in Philadelphia, Drexel is a top-ranked, comprehensive university recognized for its focus on experiential learning through cooperative education, its commitment to cutting-edge academic technology and its growing enterprise of use-inspired research. With more than 26,000 students, Drexel is one of the nation’s largest private universities.

Drexel is a leader in creating technological solutions to societal problems of the 21st century. The University’s research enterprise has increased expenditures for sponsored projects from $15 million in 1996 to approximately $111 million today. Drexel is committed to translational research and is poised to respond to novel opportunities for research, scholarship and technological development.

Drexel is one of Philadelphia’s top 10 private employers, and a major engine for economic development in the region. For nearly a decade, Drexel has been ranked in the category of Best National Universities in “America’s Best Colleges” by U.S. News & World Report.

Drexel’s 123-acre University City Campus is located in the vibrant University City district of Philadelphia, which is the nation’s fifth-largest city. The campus is a 10-minute walk from Center City, the core of Philadelphia’s commercial and business district.

Drexel teaches at two additional campuses: the Center City Campus for the College of Nursing and Health Professions and the Academy of Natural Sciences of Drexel University; the Queen Lane Campus in East Falls for the College of Medicine; and through its online platform, Drexel University Online.